

Appendix A - Appendix I



Appendix A: Acronyms, Abbreviations, and Glossary of Terms

1. Acronyms & Abbreviations

BO	Biological Opinion
BPA	Bonneville Power Administration
C & S	Commercial, Ceremonial, and Subsistence Fisheries
CCMP	Comprehensive Conservation and Management Plan
CDFG	California Department of Fish and Game
COE	U.S. Army Corps of Engineers
Corps	U.S. Army Corps of Engineers
CRCIP	Columbia River Channel Improvement Project
CRFM	Columbia River Fish Mitigation
CTWG	Caspian Tern Working Group
DEIS	Draft Environmental Impact Statement
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESI	East Sand Island
ESU	Evolutionary Significant Units
FCRPS BO	Federal Columbia River Power System Biological Opinion
FCRPS	Federal Columbia River Power System
FMP	Federal Fishery Management Plans
FOUR H'S	Hydropower, habitat loss, hatcheries, and harvest
LCREP	Lower Columbia River Estuary Project
MBTA	Migratory Bird Treaty Act
MSA	Magnuson – Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Marine Fisheries Service
NWR	National Wildlife Refuge
O & M Program	Corps Columbia River Channel Operation and Maintenance Program

1. Acronyms & Abbreviations (Continued)

ODFW	Oregon Department of Fish and Wildlife
PFMC	Pacific Fishery Management Council
PSC	Pacific Salmon Commission
RM	River Mile
RM 146	River Mile 146 (Bonneville Dam)
Service	U.S. Fish and Wildlife Service
T & C	Terms and Conditions
UKL	Upper Kalamath Lake
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WRDA	Water Resource Development Act

2. Glossary of Terms

Anadromous. Describes fish that migrate from the sea to fresh water to spawn (breed).

Arid. Lacking moisture, insufficient rainfall to support trees or woody plants.

Bioenergetics Modeling. Used to estimate consumption levels of piscivorous waterbirds. They calculate the amount of prey consumed in either biomass or numbers, based on diet composition, energy content of prey, energy requirements of individual consumers, and the number of individual consumers present (adults and juveniles).

Cyprinid. A soft-finned mainly freshwater fish typically having toothless jaws and cycloid scales

Delta. Area where a river divides before entering a larger body of water.

Demersal. Fish that live on or near the ocean bottom. They are often called benthic fish, groundfish, or bottom fish.

Dredge material. Any excavated material from waterways.

Ephemeral. Lasting a very short time; short-lived; transitory.

Estuary. The wide part of a river where it meets the sea; fresh and salt water mix.

Exclusive Economic Zone. Consists of those areas adjoining the territorial sea of the U.S. and extends up to 200 nautical miles from the U.S. coastline. Within its Exclusive Economic Zone, the U.S. has sovereign rights over all living and nonliving resources. (This also includes the territorial sea of the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, and U.S. overseas territories and possessions).

Fledglings. Young birds that have recently acquired their flight feathers.

Foraging habitat. The area where an animal searches for food and provisions.

Fry. The young of any fish.

Generation time. The average amount of time between the appearances of two successive generations (parent and offspring).

Habitat. The type of environment in which an organism or group normally lives or occurs.

Hazing. Disturbance to Caspian terns early in the nesting season through the use of repeated walk through of the nesting area by people or dogs.

Herbaceous. Relating to or characteristic of an herb as distinguished from a woody plant. Green and leaflike in appearance or texture.

Mudflats. Flat un-vegetated wetlands subject to periodic flooding and minor wave action.

Outmigrant. Juvenile salmonids (smolts) that are migrating out of their native rivers or streams on their way to ocean waters.

Pelagic. Of or pertaining to the ocean; applied especially to animals that live at the surface of the ocean, away from the coast.

2. Glossary of Terms (Continued)

Pile dike. Dike with pilings.

Piscivorous. Fish-eating.

Pit-tags. Passive Integrated Transponder or PIT tag. Very small (12 mm by 2.1 mm) glass tube containing an antenna and an integrated circuit chip inserted into the juvenile fish's body cavity that remains inactive until activated at a PIT-tag monitoring facility.

Rodeo-herbicide. A herbicide (chemical) used to control a variety of emergent (any of various plants [such as a cattail] rooted in shallow water and having most of the vegetative growth above the water) aquatic weeds.

Salmonid. Of, belonging to, or characteristic of the family Salmonidae, which includes the salmon, trout, and whitefish. Includes steelhead.

Salt ponds. Persistent hypersaline ponds that are intermittently flooded with sea water. Artificial salt ponds are surrounded by levees or dikes (manmade embankments) were created for salt harvest and have completely replaced natural salt ponds in San Francisco Bay.

Scarify. Make superficial incisions in.

Shoal. An area of shallow water; submerged sandbank visible at low water.

Smolts. A young salmon two or three years old, when it has acquired its silvery color.

Subtidal zone. Zone includes from ten meters depth to the low tide line.

Subyearling. A juvenile fish less than 1 year old.

Thermocline. A layer of water in an ocean or certain lakes, where the temperature gradient is greater than that of the warmer layer above and the colder layer below.

Trolling. To fish for by running a baited line behind a slowly moving boat.

Upwelling. An oceanographic phenomenon that occurs when strong, usually seasonal, winds push water away from the coast, bringing cold, nutrient-rich deep waters up to the surface.

Yearling. A fish that is one year old or has not completed its second year.

Appendix B: References

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B.2 Federal Register Notices

- 68 FR 16826. Notice of Intent to prepare an Environmental Impact Statement for Caspian tern management in the Columbia River estuary and notification of six public scoping meetings, April 7, 2003.
- 58 FR 53800. Endangered and Threatened Wildlife and Plants: Determination of endangered status for the Oregon chub, October 18, 1993.
- 68 FR 4433. Endangered and Threatened Wildlife and Plants; 12 month finding on a petition to list North American green sturgeon as a threatened or endangered species, January 29, 2003.



Appendix C.

Caspian Tern Predation on Juvenile Salmonid Outmigrants in the Columbia River Estuary

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June 1, 2004

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EXECUTIVE SUMMARY

- Relatively new human-constructed islands in the Columbia River estuary have provided breeding habitat for Caspian terns, where they have been able to successfully exploit juvenile salmonids as a food resource.
- The effect of Caspian tern predation: varies between years, varies among salmonid species, is greatest on steelhead, and is lowest on wild yearling chinook.
- Caspian tern predation on juvenile salmonids reduces salmon population growth rate and thus recovery, however, removing all tern predation will not-- by itself--lead to full recovery of any listed salmon and steelhead stock.
- The effect of Caspian tern predation on recovery may be comparable to fish passage improvements at Columbia River dams and harvest reductions for some Evolutionarily Significant Units.
- Relocating Caspian terns to habitat closer to the mouth of the Columbia River significantly reduced predation impact on juvenile salmon.
- Additional PIT tag data needs to be collected and evaluated to validate initial predation rates at East Sand Island.

BACKGROUND

The ecosystems inhabited by anadromous salmonids are extensive and complex. In the case of upper Columbia River and Snake River salmon and steelhead, their range extends inland as far as 1500 km and rise to elevations of 2500 m above mean sea level. Their oceanic range extends through the North Pacific Ocean to the Bering Sea and the Sea of Japan. Climate conditions and human activities have had adverse affects on water flows, river conditions, spawning and rearing habitat, ocean productivity, and eventually, salmonid survival and productivity. Wild and naturally reproducing stocks of steelhead have declined dramatically in the interior Columbia River Basin (McClure *et al.* 2003). Wild and naturally reproducing spring- and summer-run chinook stocks also have declined dramatically throughout the Pacific Northwest. As a result, nearly every population of naturally producing anadromous salmonids in the Columbia River Basin is now listed (or is a candidate for listing) under the Endangered Species Act (ESA).

Salmonids experience high mortality rates as juveniles in freshwater, the estuary and early ocean, leading researchers to suggest that reducing mortality during the juvenile stage has the potential to increase population growth rates (Kareiva *et al.* 2000). Although significant mortality of juvenile salmonids occurs in the ocean, our ability to influence ocean survival is limited. Therefore, improvements in freshwater survival and production are imperative and can directly affect the number of returning adult salmonids (Raymond 1988, Beamesderfer *et al.* 1996).

Many of the measures taken to restore anadromous salmonid production in the Columbia River Basin have focused on improving the survival of juvenile migrants through the mainstem dams. Various life-cycle models indicate that mortality of juveniles during migration in freshwater constrains anadromous salmonid production in the Columbia River Basin, thereby reducing the benefits of enhancement measures upstream (Beamesderfer *et al.* 1996, Kareiva *et al.* 2000). Increasing populations of piscivorous birds (primarily Caspian terns) nesting on islands in the Columbia River estuary annually consume large numbers of migrating juvenile salmonids (Roby

et al. 1998) and thus constitute one of the factors that currently limit salmonid stock recovery (Roby *et al.* 1998; Independent Multidisciplinary Science Team 1998; Johnson *et al.* 1999). Therefore, reducing Caspian tern predation in the estuary, is one potential mechanism to reduce mortality, thereby increasing population growth rates of Endangered Species Act (ESA) listed salmonid Evolutionarily Significant Units (ESUs)¹ in the Columbia River Basin.

Anthropogenic changes in the Columbia River Basin appear to have facilitated increases in populations of colonial waterbirds. The largest recorded colony of Caspian terns in the world now occupies East Sand Island—a natural island that has been augmented by depositing upon it dredge material from maintaining a navigation channel in the Columbia River estuary (Roby *et al.* 1998). There, the terns feed on large numbers of migrating juvenile salmon and steelhead, and basin-wide losses to avian predators now constitute a substantial proportion of individual salmonid runs (Roby *et al.* 1998).

In the early 1990s, National Marine Fisheries Service (NOAA Fisheries) staff at the Point Adams Field Station noted substantial increases in the size of newly established Caspian tern nesting colonies on Rice Island in the Columbia River estuary. Several estuary islands on which piscivorous birds nest (Fig. 1) were created from or augmented by materials dredged to maintain the Columbia River Federal Navigation Channel. Before 1984, there were no recorded observations of terns nesting in the Columbia River estuary, when approximately 1000 pairs apparently moved from Willapa Bay to nest on newly deposited dredge material on East Sand Island. In 1986, those birds moved to Rice Island, an island created by the Army Corps of Engineers for the purpose of dredge disposal. The Caspian tern colonies in the estuary have since expanded to 9,000-10,000 pairs, the largest ever reported. In 1999, the colony was encouraged to relocate to East Sand Island. In 2001, the majority of the West Coast population nested on just four acres on East Sand Island; in 2002, the terns nested on six acres.

Because of the growing concern over the increasing impacts of avian predation on salmonid smolts, NOAA Fisheries required the Bonneville Power Administration (BPA) and U.S. Army Corps of Engineers (USACE) to study avian predation in the Columbia River estuary and, if necessary, develop potential measures for managing the predator populations. These requirements were part of the 1995 Formal Consultation on the Operation of the Federal Columbia River Power System and Juvenile Transport Program (NMFS 1995). Oregon State University (OSU) and the Columbia River Inter-Tribal Fish Commission (CRITFC) began the research in 1996. The losses of salmonid smolts to newly established and expanding numbers of avian predators is of concern as currently 12 ESUs of anadromous salmonids native to the Columbia River Basin are listed as threatened or endangered under the ESA (Fig. 2).

As avian predation on salmonids is a multi-jurisdictional issue, NOAA Fisheries, the U. S. Army Corps of Engineers, U.S. Fish and Wildlife Service, the Bonneville Power Administration, the

¹ Under the Endangered Species Act, the National Marine Fisheries Service (NOAA Fisheries) lists species, subspecies and distinct population segments of vertebrates. NOAA Fisheries policy stipulates that a salmon population will be considered distinct if it represents an “evolutionary significant unit” (ESU) of the biological species (Waples 1991). For the purposes of conservation under the ESA, an Evolutionarily Significant Unit (ESU) is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991).

Columbia River Inter-Tribal Fish Commission, and resource agencies of the states of Washington, Idaho and Oregon formed the Caspian Tern Working Group (CTWG) to develop a long-term management plan for reducing tern predation in the estuary. As part of this effort, NOAA Fisheries is evaluating the overall risk that tern predation presents to listed salmonid populations.

The intent of this document is to summarize what is known about Caspian tern predation impacts to salmonids in the Columbia River estuary. We have included a summary of Caspian tern populations in the Columbia River basin and estimates of predation rates gained from recovery of PIT tags and bioenergetics modeling. We have also included analyses of predation impacts on ESA-listed steelhead through the use of a life-cycle model that focuses on Caspian terns nesting on East Sand Island since their relocation from Rice Island. This information will be useful to resource managers to develop management options to reduce predation impacts.

CASPIAN TERNS (*Sterna caspia*)

Caspian terns are highly migratory and are nearly cosmopolitan in distribution (Harrison 1983; Harrison 1984). In North America, nesting has been reported on the west coast from Baja, California to the Bering Sea, in the interior from the Gulf Coast of Texas to Lake Athabasca, Saskatchewan, and on the east coast from the Florida panhandle to Labrador. Outside of North America, nesting has been reported in Australia, New Zealand, South Africa, Asia, and Europe.

Caspian Terns winter primarily on the Pacific coast from southern California south through west Mexico and Central America (Shuford and Craig 2002). Early estimates of the Pacific Northwest population were as many as 500 pairs nesting with gulls and cormorants as far north as Klamath Lakes in Oregon (Harrison 1984). Nesting colonies were first discovered in Washington near Moses Lake and Pasco in the 1930s, but coastal colonies were not recorded until the late 1950s, when one was found in Grays Harbor (Alcorn 1958, Penland 1976, 1981). Since the early 1960s, the population has shifted from small colonies in interior California and southern Oregon to large colonies nesting on human-created habitats along the coast (Gill and Mewaldt 1983). The current population in the Columbia River basin is part of a dramatic northward and coastward expansion in range and an overall increase in Caspian tern numbers in western North America.

The numbers of Caspian terns in western North America more than doubled between 1980 and 1999 (Cuthbert and Wires 1999). One reason for the increase is that human-created habitat provides high quality nest sites and is associated with population increases in many parts of North America (Cuthbert and Wires 1999). In the Columbia River estuary, Caspian terns have increased from a few scattered individuals before 1984 to nearly 10,000 pairs in 2002 (Fig. 3).

Caspian terns arrive in the Columbia River estuary in April and begin nesting at the end of the month (Roby *et al.* 1998). To avoid mammal and avian predators, terns construct their nests on islands (Harrison 1984) and show a preference for barren sand. They are piscivorous in nature (Harrison 1984), requiring about 220 grams (roughly one-third of their body weight) of fish per day during the nesting season. The timing of courtship, nesting and chick rearing corresponds with the outmigration of many of the salmonid stocks in the basin (Collis *et al.* 2002) (Fig. 4).

ESTIMATING PREDATION IMPACTS

One approach to evaluating the extent of Caspian tern predation and resultant salmonid mortality uses bioenergetics modeling. Since 1997, biologists with the Bonneville Power Administration-funded research project ("Avian Predation on Juvenile Salmonids in the Lower Columbia River," - a joint project of Oregon State University, the U. S. Geological Survey, the Columbia River Inter-Tribal Fish Commission, and Real Time Research Consultants) have used observed salmonid consumption at tern colonies in a bioenergetics model (Roby *et al.* 1998) to estimate the consumption of salmonids in the Columbia River estuary.

This analytical approach indicates that salmon and steelhead constituted a major portion of tern diets, particularly when the birds nested on Rice Island. Diet analyses indicated that juvenile salmonids constituted 77.1% of prey items in 1997 and 72.7% of prey items in 1998 of Caspian terns nesting on Rice Island (Collis *et al.* 2002). During the peak of smolt out-migration of steelhead, yearling chinook salmon, and coho salmon through the estuary, when Caspian terns are in their incubation period in May, the diet of Caspian terns was consistently over 90% juvenile salmonids (Collis *et al.* 2002). This concentration on smolts as a food source translates into substantial juvenile mortality during the outmigration period.

Smolt consumption and the number of smolts estimated to reach the estuary from 1999 to 2002 is given in Table 1. The smolt consumption data is estimated from bioenergetics modeling, while the latter is estimated from data on fish passing through the hydropower system or transported around the system and released below Bonneville Dam. Smolt estimates are comprised only of steelhead, yearling chinook and hatchery coho, and should not be thought of as absolute totals. Estimates for subyearling chinook are not included, as their expansions are based on few data and thus not reliable, and they outmigrate later in the season and are subject to less predation pressure from terns. Estimates for chum are also not included as their outmigration is earlier in the season and they are thus subject to less predation pressure from terns.

Table 1. Estimates of outmigrating steelhead, yearling chinook and hatchery coho smolts reaching the estuary^a and of juvenile salmonids consumed by Caspian terns in the Columbia River estuary 1997-2002.

Year	Number of smolts reaching estuary in millions	Number of smolts consumed in millions (95% C.I.)
1999	63.1	11.7 (9.4 - 14.0) ^b
2000	65.6	7.3 (6.1 - 8.6) ^b
2001	60.6	5.9 (4.8 - 7.0) ^b
2002	55.5	6.5 (5.5 - 7.6) ^c

^a Data from NOAA Fisheries Fish Ecology Division, Sustainable Fisheries Division and Fish Passage Center. Includes estimated numbers of hatchery coho salmon only, no estimates are available for wild coho. Since no values for coho survival through the power system are available, estimates of survival of hatchery coho through the system were developed through the use of SIMPAS (NMFS 2000a) values for yearling chinook.

^b Collis *et al.* 2001a

^c Collis *et al.* 2002

Another approach uses detections of passive integrated transponders (PIT) tags on Caspian tern colonies to estimate salmonid predation rates overall as well as by ESU (Collis *et al.* 2001b, Ryan *et al.* 2001). In 1997 and 1998, 1 - 2 million ESA-listed salmonid smolts entered the Columbia River estuary, representing 1 - 2 % of all salmonid smolts migrating to the estuary. However, in 1999, seven additional ESUs of anadromous salmonids in the Columbia River Basin were listed, and roughly 6 million ESA-listed salmonid smolts entered the estuary along with over 80 million unlisted smolts, which were primarily of hatchery origin. The majority of juvenile salmonids in the estuary are of hatchery origin and the majority being consumed by Caspian terns are hatchery fish (Independent Multidisciplinary Science Team 1998). Overall, Caspian terns consumed approximately 6% to 14% of the estimated outmigrating population of juvenile salmonids originating from the Columbia River basin.

Since 1987, researchers in the Columbia River basin have placed over five million PIT tags in juvenile salmonids for a variety of studies (Ryan *et al.* 2001). Identifying PIT tags on bird colonies can provide a minimum estimate of proportion of the stocks that were consumed by terns in these colonies. In recent years, approximately one million juvenile salmonids have been PIT-tagged annually (Collis *et al.* 2001b), the vast majority of which are steelhead and chinook from the Snake River basin. Using PIT tag detection equipment, over 115,000 PIT tags were detected on Rice Island in 1998 and 1999 (Ryan *et al.* 2001). Collis *et al.* (2001b) indicate that the majority of these PIT tags detected were from steelhead and chinook, coho and sockeye salmon. Of the PIT tags placed in steelhead smolts in 1997 that were detected at Bonneville dam, 2.8% of wild smolts and 5.4% of hatchery-raised smolts were subsequently detected on the Rice Island tern colony (Collis *et al.* 2001b). For steelhead PIT-tagged in 1998 and detected at Bonneville Dam, 11.7% of wild smolts and 13.4% of hatchery-raised smolts were subsequently detected on the Rice Island tern colony (Collis *et al.* 2001b). For yearling chinook salmon PIT-tagged in 1998 and detected at Bonneville Dam, 0.5% of wild smolts and 1.6% of hatchery-raised smolts were subsequently detected on the Rice Island tern colony (Collis *et al.* 2001b). PIT tag data also determined that steelhead experienced higher predation rates (0.6% to 8.1% on East Sand Island and 1.3% to 9.4% on Rice Island) than chinook salmon (0.2% to 2.0% on East Sand Island and 0.6% to 1.6% on Rice Island).

There are some important uncertainties from estimating predation rates for Caspian terns. Predation impacts derived from PIT tags, while more direct than those derived from bioenergetics models, represent minimum estimates of the proportion of stocks consumed--an unknown number of tags are regurgitated/defecated off-colony or removed by wind and water erosion, tags may be damaged and undetectable, and not all tags are detected (Ryan *et al.* 2001, Collis *et al.* 2001b, Collis *et al.* 2002). Also, predation rates vary annually and by the methodology used to make the estimate, making it difficult to derive a single predation rate. Although there is good correspondence of predation rates between methodological estimates, utilizing the upper and lower bounds of the predation rates to bracket potential recovery improvements represent the most reliable approach that currently should be used to assess potential impacts of smolt predation by Caspian terns. Finally, it is clear that predation rates are not uniform for all salmon species, thus evaluation of the impact of Caspian tern predation should be species or ESU-specific, to the extent possible.

RELOCATION EFFORTS

Efforts to relocate the terns to East Sand Island began in 1999, and these efforts have apparently succeeded in reducing consumption of smolts without affecting tern productivity. The Caspian Tern Working Group relocated the Caspian tern colony from Rice Island to East Sand Island--a site lower in the estuary with abundant alternate prey sources--in an attempt to decrease losses of juvenile salmonids. Over the last few years, consumption of salmonids in the estuary has been lower than previously, while consumption of alternative prey species has increased. Relocating the colony to East Sand Island, which is lower in the estuary and closer to periodically abundant Pacific herring [Clupeidae] and anchovies [Engraulidae] has contributed to the reduction. In 2000, salmonid consumption for both islands combined was estimated at 7.3 million smolts, which is 4.4 million less than in 1999--the last time a substantial number of terns nested on Rice Island (Collis *et al.* 2001a, USFWS 2001). In 2001, salmonid consumption was estimated at 5.9 million smolts, which is 5.9 million less than in 1999 (Collis *et al.* 2001a).

Caspian tern diets also shifted following relocation from Rice Island. Observed diets, which consisted of almost exclusively salmonids at Rice Island (77% in 1999 and 90% in 2000), shifted to 46%, 47% and 33% salmonids at East Sand Island in 1999, 2000 and 2001 respectively (Collis *et al.* 2001a, Roby *et al.* 2003). These data represent substantial declines in juvenile salmonid mortalities from Caspian tern predation. These observational data were substantiated by PIT tag detections on the two islands in 1999 and 2002. Significantly fewer PIT tags detected per nest on East Sand Island in 1999 and 2000 than were detected on Rice Island in 1999 and 2000 (Table 2).

Table 2. Ratio of PIT tags detected per Caspian tern nesting pair on East Sand Island and Rice Island in 1999 and 2000.

	1999	2000
Rice Island	0.59	1.25
East Sand Island	0.32	0.35

In addition to reductions in Caspian tern predation on juvenile salmonids, relocation efforts have not significantly impaired Caspian tern reproductive performance. Nesting success has been substantially higher for Caspian terns nesting on East Sand Island as compared to Rice Island (Roby *et al.* 2003), and productivity at East Sand Island in 2001 was the highest recorded for terns nesting in the estuary (Collis *et al.* 2001a). It appears that relocating terns to East Sand Island accomplished the goal of reducing consumption of juvenile salmon without adversely affecting tern population growth rates.

PREDATION IMPACT OF CASPIAN TERNS ON EAST SAND ISLAND

Data and Analyses

In this report, we focus on predation on steelhead by Caspian terns nesting on East Sand Island from 1999-2002. We focus on steelhead because they are the most heavily affected of the outmigrating juvenile salmonids (Ryan *et al.* 2003, Roby *et al.* 2003); estimates of the potential benefit of reducing Caspian tern predation are thus the greatest for steelhead and would encompass potential benefits afforded to other salmonid species. We focus on the Caspian tern colonies on East Sand Island in the lower estuary of the Columbia River, because the colony represents the majority of the West Coast Caspian tern population, and we focus on 1999-2002 because this represents the time period, after relocation from Rice Island, during which this colony has persisted in the Columbia River estuary. In general, both analytical techniques (PIT tag detections; bioenergetics modeling) found a positive relationship between the number of Caspian terns on East Sand Island and the predation rate on juvenile salmonids, *i.e.* the proportion of available juvenile salmonids consumed (Fig. 5).

Bioenergetics modeling, which has been used to estimate the effect of Caspian tern predators on juvenile salmonids on Rice Island (Roby *et al.* 2003), was used to calculate predation rates (%) (estimated # of steelhead consumed/estimated # of steelhead available in the estuary x 100) using updated and refined estimates of the number of outmigrating steelhead that run the river or are transported to below Bonneville Dam (Table 3; Fig. 6).

Table 3. Estimates of nesting population, the number of steelhead consumed, the number of steelhead available, and predation rates of Caspian terns nesting on East Sand Island using bioenergetics modeling (D. Lyons and D. Marsh, unpublished data).

Year	# tern pairs	# of steelhead consumed	# of steelhead available	Predation Rate % (95% C.I.)
1999	547	72,844	13,501,917	0.5 (0.3 - 0.8)
2000	8513	842,433	13,359,935	6.3 (4.4 - 8.3)
2001	8982	571,441	13,560,423	4.2 (3.2 - 5.2)
2002	9933	741,772	12,124,528	6.1 (4.8 - 7.4)

Although the relationship between tern abundance and predation rate is not known with certainty, possibilities include linear, exponential, asymptotic, and logistic. A simple linear response of the predation rate on all steelhead to the number of Caspian terns nesting on East Sand Island during the breeding seasons of 1999-2002 appears to describe the relationship.² Further support for a linear relationship between estimates of predation rate and the number of terns nesting on East Sand Island comes from per capita consumption rates (# of smolts consumed/adult tern), which have been relatively constant throughout the range of colony sizes

² Analyses of influence statistics on linear regressions of PIT tag recoveries on Caspian Tern numbers demonstrated that the 1999 data point exacted little leverage on the regression analyses (P. Wilson, USFWS, unpublished data). He concluded that regressions including the 1999 data resulted in reasonable representations of the data, provided they were modeled through the origin.

on East Sand Island from 1999-2003. The per capita consumption rate in 1999 (mean = 437.5 salmonids) was virtually the same as that in 2000 (mean = 431.1 salmonids), despite a ten-fold difference in Caspian Tern numbers (1094 in 1999 vs 17,026 in 2000) (D. Roby and D. Lyons, unpublished data). A relatively constant per capita consumption rates for salmonids has also been seen on Rice Island over a range of tern population numbers from 1997-2000. The per capita consumption rate on Rice Island in 1999 (mean = 784.1 salmonids) was virtually the same as in 2000 (mean = 739.7 salmonids) despite a ten-fold difference in colony size (8328 nesting pairs in 1999 vs. 588 nesting pairs in 2000) D. Roby and D. Lyons, unpublished data). This suggests that the Caspian Tern predation rate is not affected by prey availability, at least over the range of values experienced from 1999-2003. While non-linear relationships described the data just as well as the linear one, per capita consumption rates associated with an exponential relationship (increasing with an increase in terns), logistic relationship (parabolic over the range of tern numbers), or asymptotic relationship (decreasing with an increase in tern numbers) were not observed.

As both analytical techniques produced similar results, we focus on the PIT tag detection analytical technique--which has also been used to estimate the effect of Caspian tern predators on juvenile salmonid outmigrants (Ryan *et al.* 2003)--to calculate estimates of predation rates on steelhead. Moreover, as the PIT tag detection approach makes possible ESU-specific predation rate estimates, subsequent analyses presented use PIT tag predation rates. Estimates of predation rates (%) from this approach (# PIT tags detected on East Sand Island/# PIT tags detected at Bonneville Dam x 100) also showed a linear response to the number of Caspian terns nesting on East Sand Island during the breeding seasons of 1999-2002 (Figure 7).

We then used these estimates of predation rate (derived from the number of terns) to derive the likely impact on the overall population trajectory for steelhead in the Columbia River. We first calculated the median population growth rate λ using the methods in Holmes (2001) and McClure *et al.* (2003). These methods have been: developed for data sets with high sampling error and age-structure cycles (Holmes 2001), extensively tested using simulations for threatened/endangered populations as well as for low-risk stocks (Holmes 2004), and have been cross-validated with time series data (Holmes and Fagan 2002). We chose this parameter for two reasons. First, population growth rate is an essential parameter in viability assessments and a primary predictor of extinction risk. Second, calculating population growth rate in this manner (annualized), provides a standard metric for comparison between species (or ESUs) with different generation times.

We next calculated the deterministic change in population growth rates given standard reductions in mortality. Because the vast majority of steelhead in the interior Columbia are semelparous, the percent increase in λ attributable to an increase in survival at a particular life history stage can be approximated as:

$$\Delta\lambda = \left[\left(\frac{S_{new}}{S_{old}} \right)^{1/G} - 1 \right] \times 100$$

where S_{old} is the initial survival rate before recovery action, S_{new} is the survival rate following the recovery action, and G is the average generation time (McClure *et al.* 2003). This calculation assumes that the change in survival due to tern predation is independent of density and of changes in survival elsewhere in the salmonid life history. We did not use a formal Leslie matrix analysis to estimate changes in population growth rates because data to parameterize a detailed model for steelhead were not available.

We estimated the impact of Caspian tern predation on the population growth rate (λ) of all steelhead in the Columbia River basin to compare predation rate estimates from bioenergetics modeling and PIT tag detection approaches. Because of the similarity in the results between the two approaches, we present both for comparative purposes (Table 4).

Table 4. Estimated predation rate (PR) and percent increase in the population growth rate (λ) of all steelhead in the Columbia River basin if populations of Caspian Terns breeding on East Sand Island are reduced to that number, assuming a linear relationship between predation rates and Caspian Tern breeding population size (see Figs. 7-8). Calculations used the predation rate estimated for 20,000 terns from linear regressions of (a) *recovery of PIT-tags* and (b) *bioenergetics modeling*, and the generation time for the Snake River basin*.

(a)

Number of tern pairs	PR	Increase in λ (%)
10000	8.7	0.0
9375	8.1	0.1
8750	7.6	0.2
8125	7.0	0.4
7500	6.5	0.5
6875	6.0	0.6
6250	5.4	0.7
5625	4.9	0.9
5000	4.3	1.0
4375	3.8	1.1
3750	3.2	1.2
3125	2.7	1.3
2500	2.2	1.4
1875	1.6	1.6
1250	1.1	1.7
625	0.5	1.8
0	0.0	1.9
4.79*		

(b)

Number of tern pairs	PR	Increase in λ (%)
10000	6.1	0.0
9375	5.7	0.1
8750	5.3	0.2
8125	4.9	0.3
7500	4.6	0.3
6875	4.2	0.4
6250	3.8	0.5
5625	3.4	0.6
5000	3.0	0.7
4375	2.6	0.7
3750	2.3	0.8
3125	1.9	0.9
2500	1.5	1.0
1875	1.1	1.1
1250	0.8	1.2
625	0.4	1.2
0	0.0	1.3
4.79*		

The predation rate for 10,000 Caspian tern pairs on all steelhead was estimated using the regression equations generated using both approaches. Reductions in predation rate corresponding to lowered tern population sizes were used to model the potential increase in λ , assuming all steelhead mortality attributable to terns is not compensated for by mortality due to other sources. The maximum proportional increase in λ corresponding to complete elimination of mortality due to tern predation was 1.9% using the PIT-tag estimate of predation rate and 1.3% using the bioenergetics modeling estimate of predation rate; the proportional increase in λ

corresponding to a 50% reduction of mortality due to tern predation was 0.97% using the PIT-tag estimate of predation rate and 0.67% using the bioenergetics modeling estimate of predation rate.

To investigate how variation in generation times in Columbia River basin steelhead influenced model output, we also estimated the potential increase in λ using the recovery of PIT tags for all steelhead using the range of generation times (4.27 – 4.85) that have been estimated for steelhead ESUs in the Columbia River basin. This resulted in maximum increases in λ (corresponding to a minimum breeding population size of 0 tern pairs) that ranged from a low of 1.88% to a high of 2.44%.

As the PIT tag detection approach enables ESU-specific estimates of predation rate (and hence proportion increase in λ), we used the life-cycle model to estimate impact of Caspian tern predation on the population growth rate (λ) of steelhead ESUs using predation rates estimated from PIT tag detections (Table 5). Predation rates for 10,000 Caspian tern pairs on four of the five ESA-listed steelhead ESUs were estimated using linear regression (Figs. 8-11). Reductions in predation rate corresponding to lowered tern population sizes were used to model the potential increase in λ , again assuming all steelhead mortality attributable to terns is additive, *i.e.* not compensated for by mortality due to other sources. The maximum proportional increase in λ corresponding to complete elimination of mortality due to tern predation ranged from 1.6% to 4.9% under the most optimistic assumptions (hatchery fish do not reproduce) and 0.7% to 1.0% under the most pessimistic assumptions (hatchery fish reproduce at the same rate as wild-born fish).

Although this analysis was restricted to assessing the potential effects of reducing Caspian tern predation, McClure *et al.* (2003) estimated the effects of other potential conservation actions, including changes to the hydropower system and reductions in harvest. Because these estimates were calculated using similar methods, they are comparable to our results, and we present them here to provide context.

Table 5. Estimated predation rates (PR), % increase in λ predicted from predation rates at those levels, and population growth rate (λ) of four of the five listed steelhead ESUs in the Columbia River basin given a range of Caspian Terns breeding on East Sand Island. Calculations used the predation rate estimated from the linear regression of ESU-specific PIT-tag recoveries (see Figs. 7-10). Generation times* and lambda values (1980-2000) for each ESU are taken from McClure *et al.* (2003), where λ has been estimated under different assumptions about hatchery fish reproduction (λ = hatchery fish on the spawning grounds do not reproduce and λ_h = hatchery fish reproduce at the same rate as wild-born fish).

	Snake River				Upper Columbia River				Middle Columbia River				Lower Columbia River			
# Pairs	PR	% $\Delta\lambda$	λ	λ_h	PR	% $\Delta\lambda$	λ	λ_h	PR	% $\Delta\lambda$	λ	λ_h	PR	% $\Delta\lambda$	λ	λ_h
10000	8.7	0.0	1.02	0.96	16.4	0.0	1.00	0.63	8.7	0.0	0.97	0.95	6.9	0.0	0.92	0.81
9375	8.2	0.1	1.02	0.96	15.3	0.3	1.00	0.63	8.2	0.1	0.97	0.95	6.5	0.1	0.92	0.81
8750	7.6	0.2	1.02	0.96	14.3	0.6	1.01	0.63	7.6	0.2	0.97	0.95	6.1	0.2	0.92	0.81
8125	7.1	0.4	1.02	0.96	13.3	1.0	1.01	0.64	7.1	0.4	0.97	0.95	5.6	0.3	0.92	0.81
7500	6.5	0.5	1.02	0.96	12.3	1.3	1.01	0.64	6.5	0.5	0.98	0.96	5.2	0.4	0.92	0.81
6875	6.0	0.6	1.03	0.97	11.2	1.6	1.02	0.64	6.0	0.6	0.98	0.96	4.8	0.5	0.92	0.81
6250	5.4	0.7	1.03	0.97	10.2	1.9	1.02	0.64	5.4	0.7	0.98	0.96	4.3	0.6	0.93	0.82
5625	4.9	0.9	1.03	0.97	9.2	2.2	1.02	0.64	4.9	0.8	0.98	0.96	3.9	0.7	0.93	0.82
5000	4.4	1.0	1.03	0.97	8.2	2.5	1.02	0.65	4.4	1.0	0.98	0.96	3.5	0.8	0.93	0.82
4375	3.8	1.1	1.03	0.97	7.2	2.8	1.03	0.65	3.8	1.1	0.98	0.96	3.0	0.9	0.93	0.82
3750	3.3	1.2	1.03	0.97	6.1	3.1	1.03	0.65	3.3	1.2	0.98	0.96	2.6	1.0	0.93	0.82
3125	2.7	1.3	1.03	0.97	5.1	3.4	1.03	0.65	2.7	1.3	0.98	0.96	2.2	1.1	0.93	0.82
2500	2.2	1.5	1.04	0.97	4.1	3.7	1.04	0.65	2.2	1.4	0.98	0.96	1.7	1.2	0.93	0.82
1875	1.6	1.6	1.04	0.98	3.1	4.0	1.04	0.66	1.6	1.6	0.98	0.96	1.3	1.3	0.93	0.82
1250	1.1	1.7	1.04	0.98	2.0	4.3	1.04	0.66	1.1	1.7	0.99	0.97	0.9	1.4	0.93	0.82
625	0.6	1.8	1.04	0.98	1.0	4.6	1.05	0.66	0.5	1.8	0.99	0.97	0.4	1.5	0.93	0.82
0	0.0	1.9	1.04	0.98	0.0	4.9	1.05	0.66	0.0	1.9	0.99	0.97	0.0	1.6	0.93	0.82
	4.79*				4.27*				4.85*				4.63*			

For comparison, we include the results of similar modeling exercises conducted to estimate increases in population growth rates anticipated from changes to hydropower or harvest operations (Table 6). The estimates for hydropower improvement come from changes to improve passage for both adults and juveniles called for in NOAA Fisheries' FY 2000 Biological Opinion on operation of the Federal Columbia River Hydropower System (FCRPS) (NMFS 2000b, McClure *et al.* 2003). The estimates for harvest elimination come from McClure *et al.* (2003) and have been largely realized already. Thus, the potential increase in λ that may be realized from eliminating Caspian tern predation (1.6 - 4.9%) is equivalent to that of hydropower improvements but well below that of elimination of harvest reductions, all else being equal.

Table 6. Potential increases (%) in population growth rate of Columbia River basin steelhead ESUs corresponding to passage improvements in the Federal Columbia River Hydropower System and elimination of harvest.

	Snake River	Upper Columbia River	Middle Columbia River	Lower Columbia River
Caspian Tern predation (eliminated)	1.9	4.9	1.9	1.6
Caspian Tern predation (halved)	1.0	2.5	1.0	0.8
Hydropower improvements	1-2	2.0-4.0	2.0-3.0	0.0-1.0
Harvest elimination	4.0-7.0	8.0	4.0	6.0-8.0

ADDITIONAL AVIAN PREDATION IMPACTS

Other avian predators of juvenile salmonids in the Columbia River estuary include Double-crested Cormorants (*Phalacrocorax auritus*), California Gulls (*Larus californicus*), Ring-billed Gulls (*L. delawarensis*), and members of the Glaucous-winged/Western Gull hybrid complex (*L. glaucescens/L. occidentalis*) (Roby *et al.* 1998, Collis *et al.* 2001a). Calculations of predation rates based upon the PIT tag detection approach for cormorants nesting on East Sand Island are provided for purposes of comparison and to place Caspian tern predation in context with other avian predation in the Columbia River basin (Table 7).

Table 7. Comparison of estimated predation rates (%) for Double-crested cormorants and Caspian terns breeding on East Sand Island on all steelhead in the Columbia River basin. Predation rates were calculated as the percent of PIT tags detected at Bonneville Dam that were later detected on cormorant colonies on East Sand Island.

	1999	2000	2001	2002
Caspian terns	0.8	6.7	7.7	9.2
Double-crested cormorants	0.6	2.5	1.2	0.7

Analyses of PIT tag detections on East Sand Island cormorant colonies made it possible to compare these sources of mortality by ESU; these methods found not insubstantial predation rate estimates from double-crested cormorants as compared to Caspian terns (Table 8).

Table 8. Estimated predation rates (%) for Caspian terns and Double-crested cormorants breeding on East Sand Island on four of the five ESA-listed steelhead ESUs in the Columbia River basin. Predation rates were calculated as the percent of PIT tags detected at Bonneville Dam that were later detected on cormorant colonies on East Sand Island.

	Caspian terns				Double-crested cormorants			
	1999	2000	2001	2002	1999	2000	2001	2002
Snake River	0.7	5.8	7.2	10.6	0.6	2.7	1.3	0.7
Upper Columbia River	0.6	10.9	25.2	9.3	0.6	2.0	0.8	0.9
Middle Columbia River	0.4	6.8	10.0	7.2	0.4	1.9	0.8	0.3
Lower Columbia River	0.4	6.1	6.7	6.3	0.3	0.8	1.1	0.2

AVIAN PREDATION UPRIVER OF THE COLUMBIA RIVER ESTUARY

Substantial numbers of salmonid smolts are also lost to avian predators--terns, cormorants, and gulls--upriver of East Sand Island. In particular, a significant number of Caspian terns nest on Crescent Island in the mid-Columbia River. The proportion of their diet represented by salmonid smolts is greater than for terns nesting on East Sand Island (Collis *et al.* 2001a), and comparisons of the potential impact of this predation remains an important consideration in any analysis of avian predation impacts in the Columbia River basin (Table 9).

Table 9. Estimated predation rates (%) for Caspian terns and all birds breeding on Crescent Island on all steelhead ESUs in the Columbia River basin. Predation rates were calculated as the percent of PIT tags detected at Lower Monumental Dam that were later detected on cormorant colonies on Crescent Island (B. Ryan, unpubl. data).

	1999	2000	2001	2002
Caspian terns	4.1	1.7	13.2	7.2
Other birds	0.4	2.0	7.9	2.9

CONCLUSIONS

Many evaluations of salmonid predation by Caspian terns in the Columbia River estuary have indicated that substantial numbers of juvenile salmonids are being consumed (Roby *et al.* 1998, Collis *et al.* 2001a, 2001b, Ryan *et al.* 2001, Ryan *et al.* 2003, Roby *et al.* 2003). The two

approaches that have been used to evaluate the extent of that impact yield similar results and appear to provide reasonable estimates of predation rates. The PIT tag recovery approach has also revealed species-specific vulnerability to Caspian tern predation--steelhead are substantially more susceptible to tern predation than yearling chinook. Efforts to reduce predation by moving the colony from Rice Island (more central to the Columbia River estuary) to East Sand Island (located towards the mouth of the Columbia River) have successfully decreased overall predation as fewer salmon are consumed per nest on East Sand Island. The decrease in consumption has been substantial. However, PIT tag data on predation rates needs to be further collected at East Sand to confirm initial observations and to document that the relocation efforts have been successful in reducing impacts for all ESUs (particularly for steelhead).

Several factors must be considered when interpreting the results of these calculations. Perhaps the most important factor is that this type of calculation assumes that there is no compensatory mortality later in the life cycle, and that the benefits from any reduction in tern predation are fully realized. In their assessment of predation impact by Rice Island terns on salmonids in 1997-1998, Roby et al (2003) hypothesized that tern predation was 50% additive. Given these limitations and uncertainties, the estimates of percent change in population growth rates should be viewed as maximum potential improvements. Realized improvements in population growth would likely be lower from any management action that reduces Caspian tern predation impacts on salmonid ESUs. These results may not be as easy to achieve as they are to calculate. It is also important to recognize that other factors such as ocean conditions may also influence population growth rate to a greater degree than the potential gains that may be realized from reducing predation by one species of avian predator on one island located in the lower estuary of the Columbia River basin.

Not all listed salmonid populations have declined because of the same factors or combination of factors, and not all populations could be expected to respond positively to any particular management measure or combination of measures. In the case of the avian predator populations discussed here, artificial islands (such as Rice Island) have promoted the development of unprecedented large colonies of piscivorous birds with subsequent increases in losses of juvenile salmonids from predation.

Finally, additional factors may influence the gains in population growth rate that may be realized from reducing predation rates on outmigrating juvenile salmonids. These include, but are not limited to: hydropower operations, harvest rates, habitat conditions, the influence of hatchery fish and exotic species, ocean conditions, and climate change.

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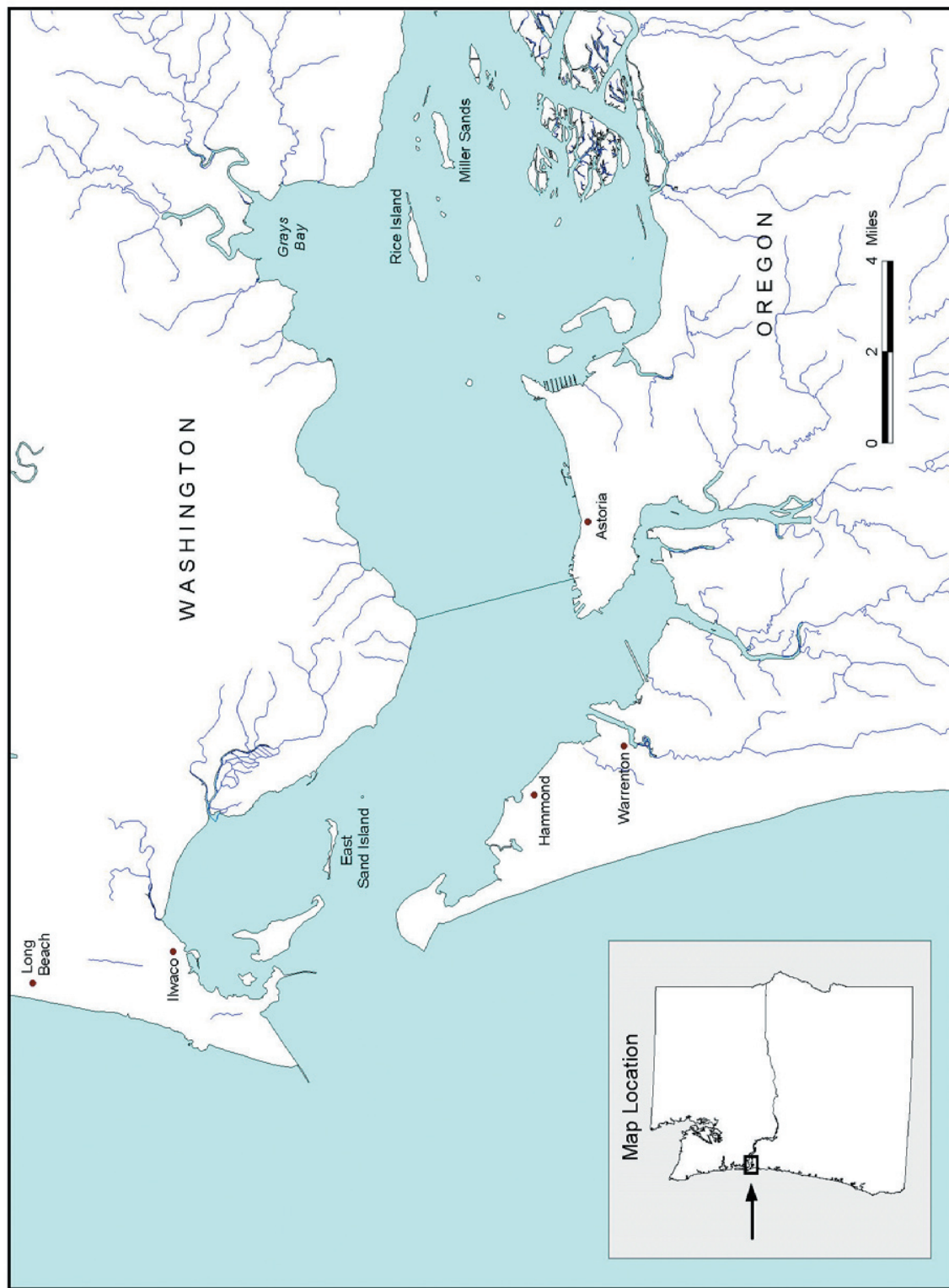


Figure 1. Map of the Columbia River estuary showing the relative locations of East Sand and Rice Islands, sites of Caspian tern nesting colonies.

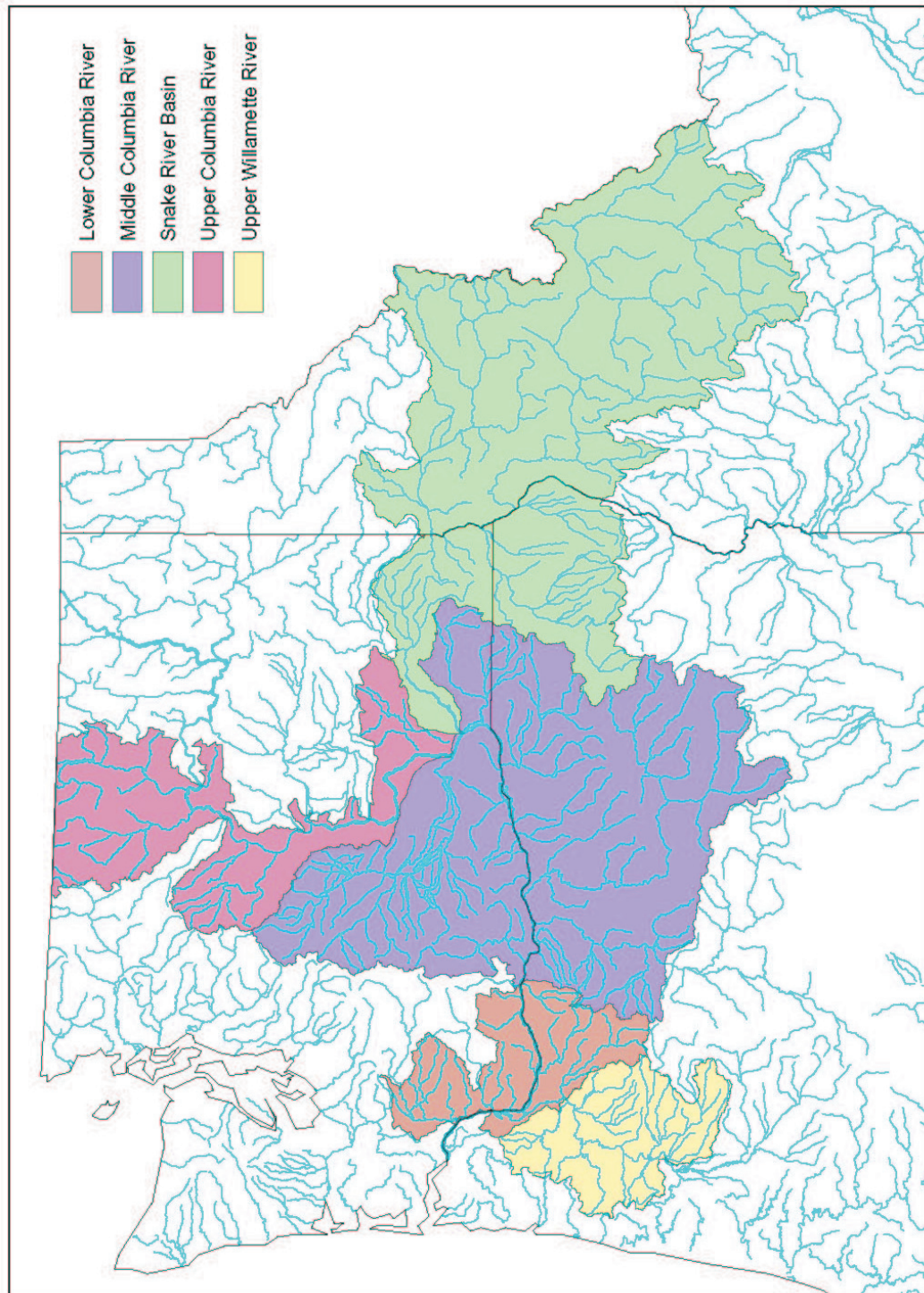


Figure 2. Map of Columbia River Basin showing the locations of the ESA-listed Lower Columbia River, Upper Willamette River, Middle Columbia River, Upper Columbia River and Snake River steelhead ESUs.

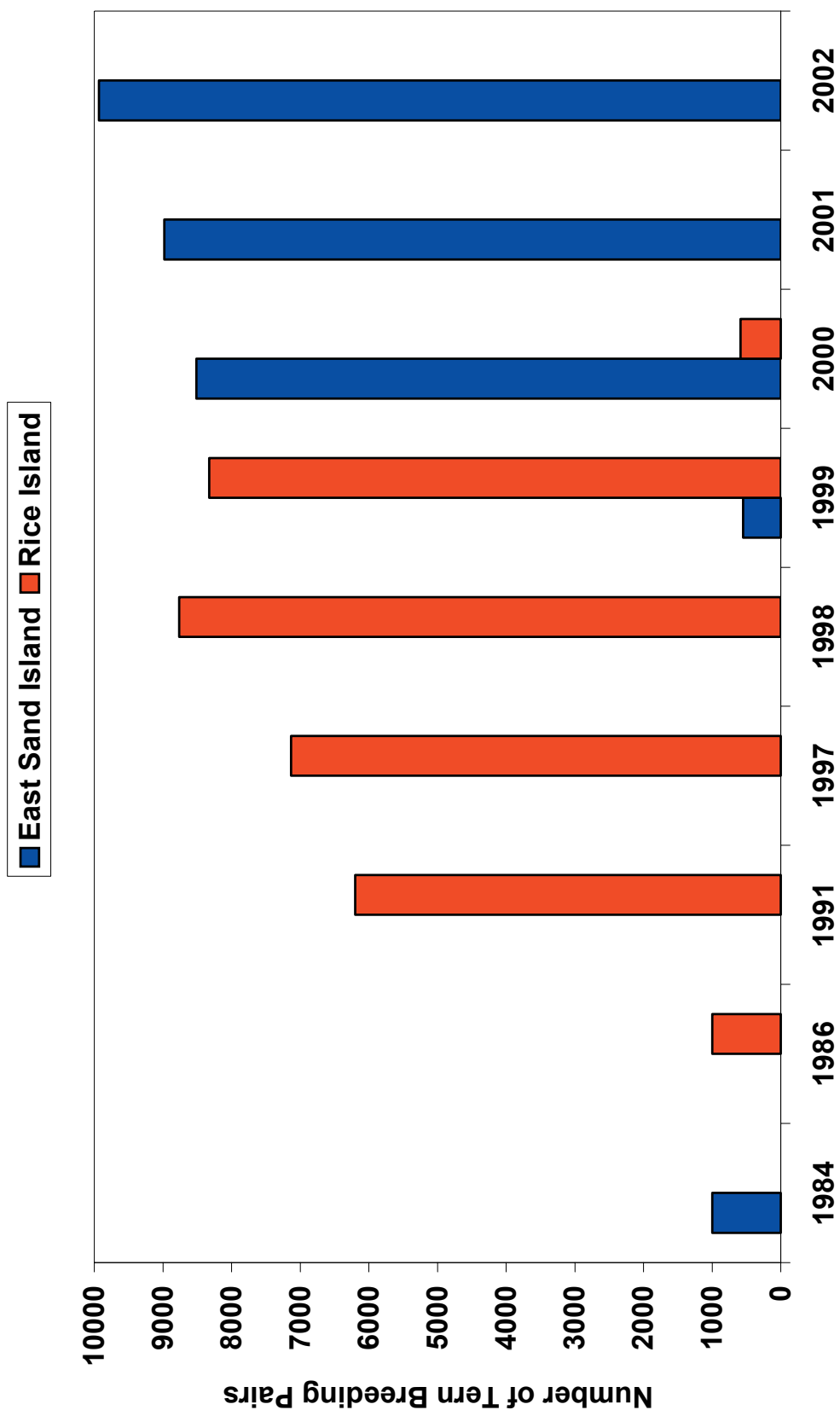


Figure 3. Numbers of Caspian terns nesting on islands in the Columbia River estuary since 1984.



Figure 4. Arrival times of juvenile salmonids and nesting period of Caspian terns in the Columbia River estuary.

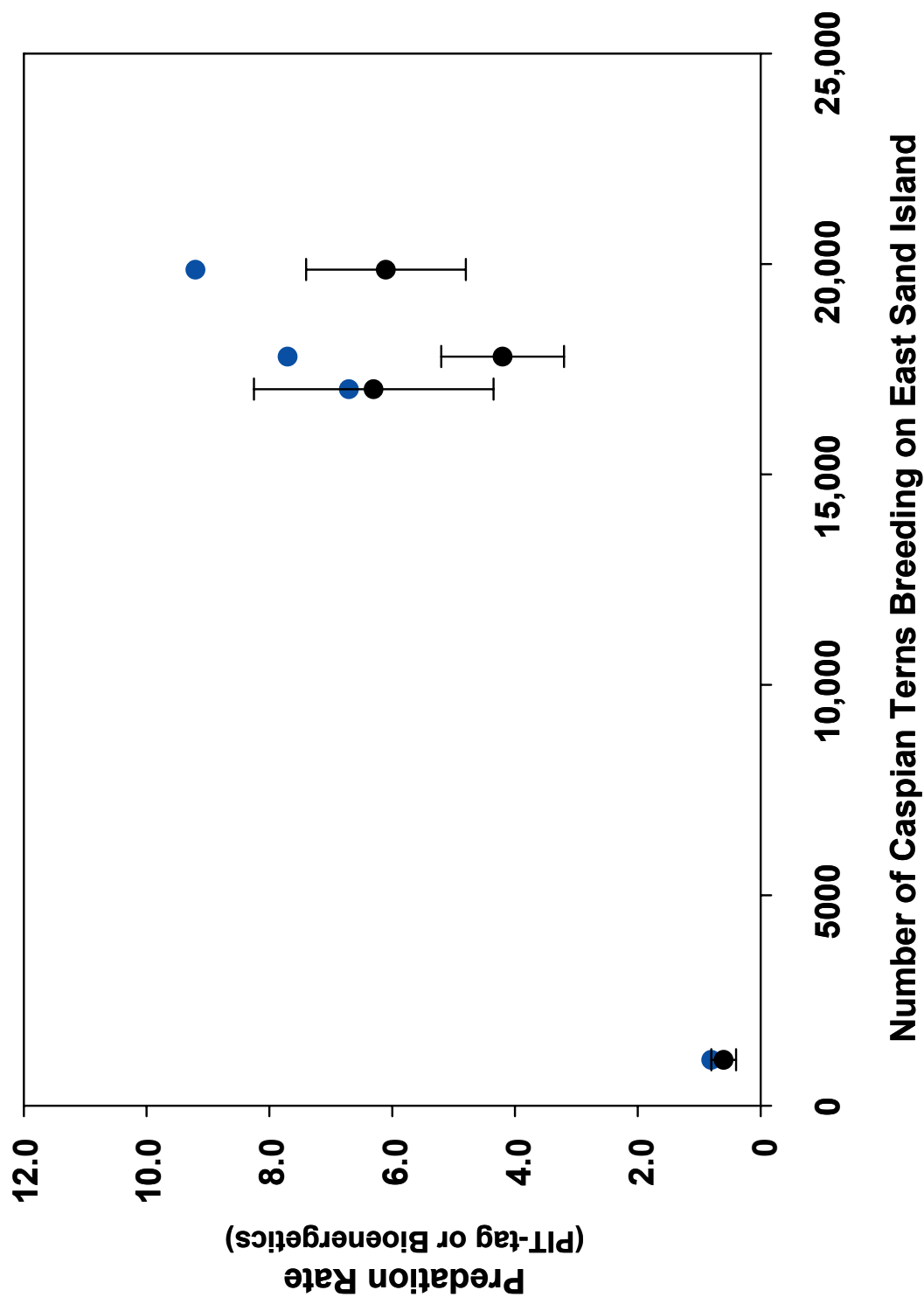


Figure 5. Estimated predation rates on *all Columbia River basin steelhead* in the Columbia River estuary by Caspian Terns (1999-2002) using bioenergetics modeling (black symbols) and recovery of PIT tags (blue symbols). Error bars on bioenergetics estimates represent 95% confidence limits.

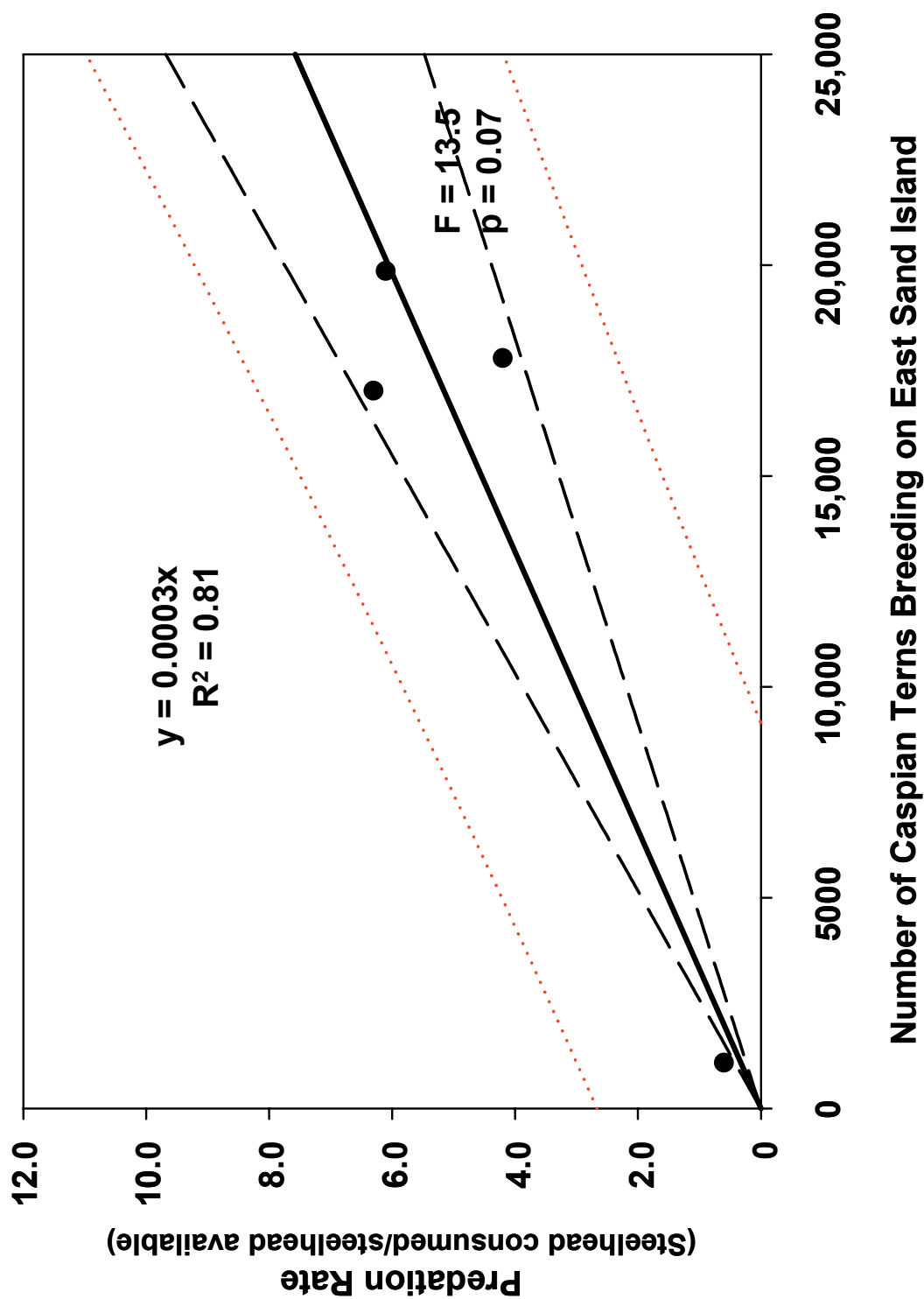
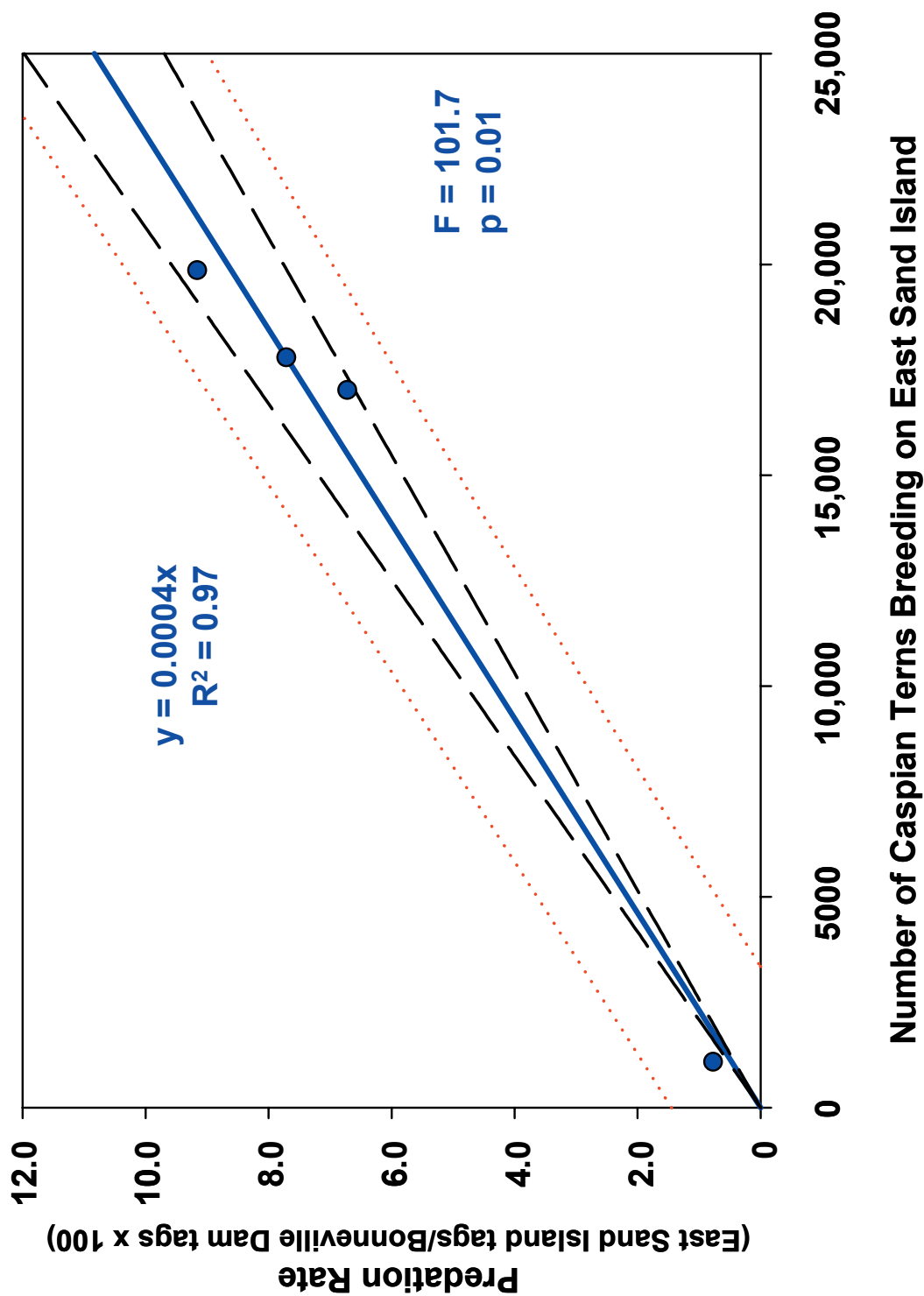
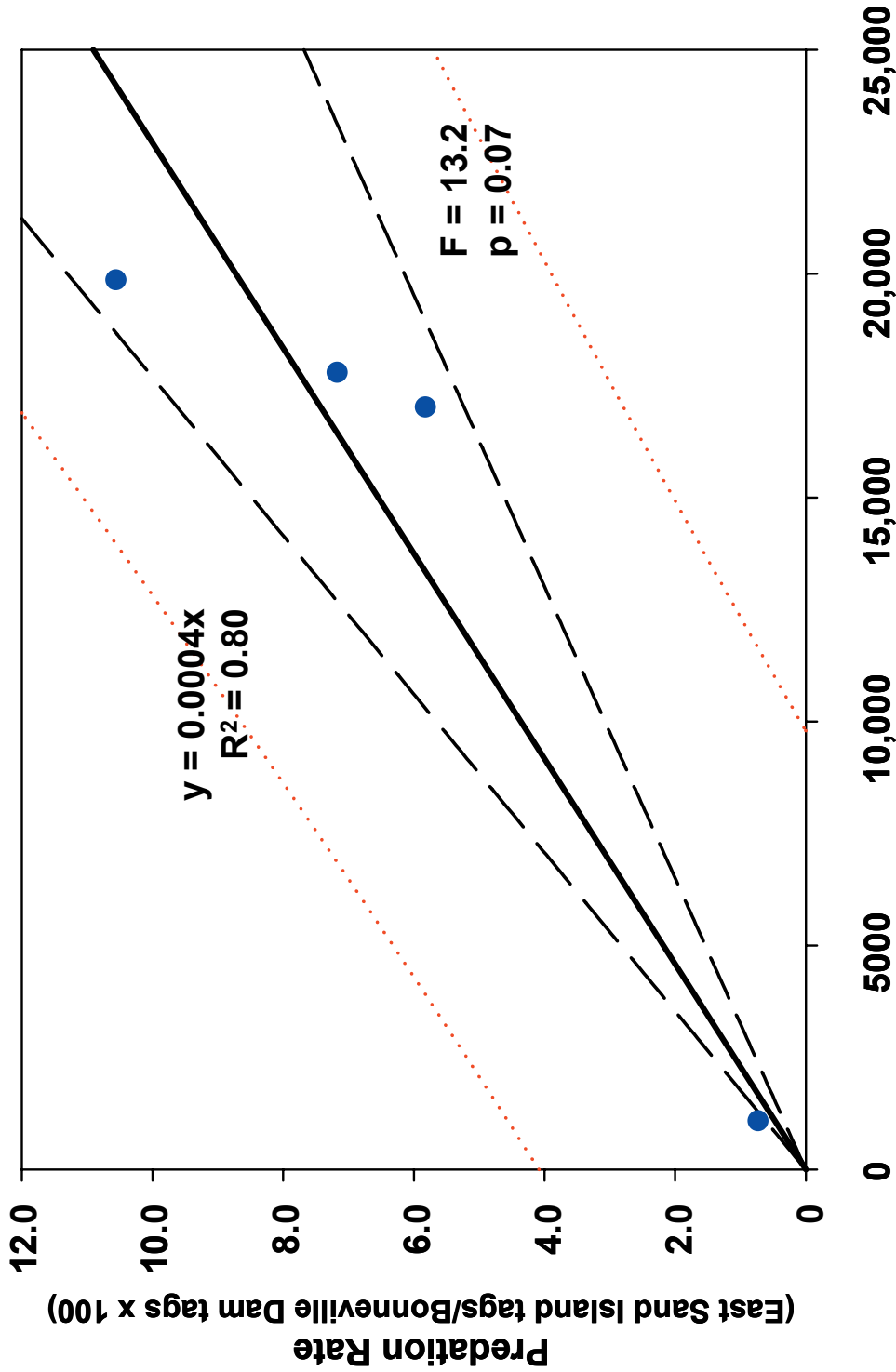


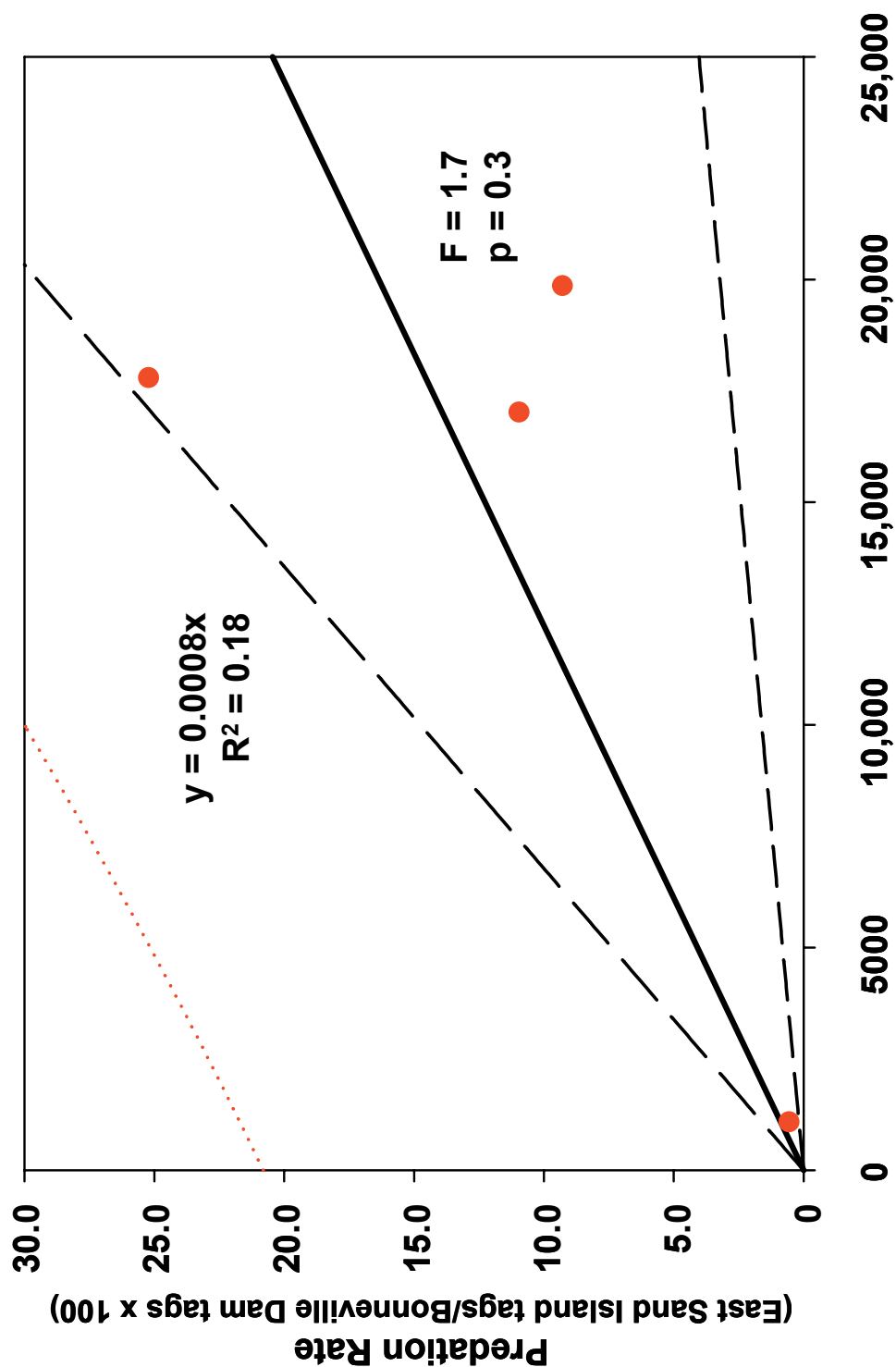
Figure 6. Linear regression of predation rates on *all Columbia River basin steelhead* in the Columbia River estuary by Caspian Terns breeding on East Sand Island (1999-2002) estimated using *bioenergetics modeling*. Dashed black lines represent 95% confidence limits; dotted red lines represent 95% prediction limits.





Number of Caspian Terns Breeding on East Sand Island

Figure 8. Linear regression of predation rates on the *Snake River steelhead ESU* in the Columbia River estuary by Caspian Terns breeding on East Sand Island (1999-2002) estimated using *recovery of PIT tags*. Dashed black lines represent 95% confidence limits; dotted red lines represent 95% prediction limits.



Number of Caspian Terns Breeding on East Sand Island

Figure 9. Linear regression of predation rates on the *Upper Columbia River steelhead ESU* in the Columbia River estuary by Caspian Terns breeding on East Sand Island (1999-2002) estimated using *recovery of PIT tags*. Dashed black lines represent 95% confidence limits; dotted red lines represent 95% prediction limits.

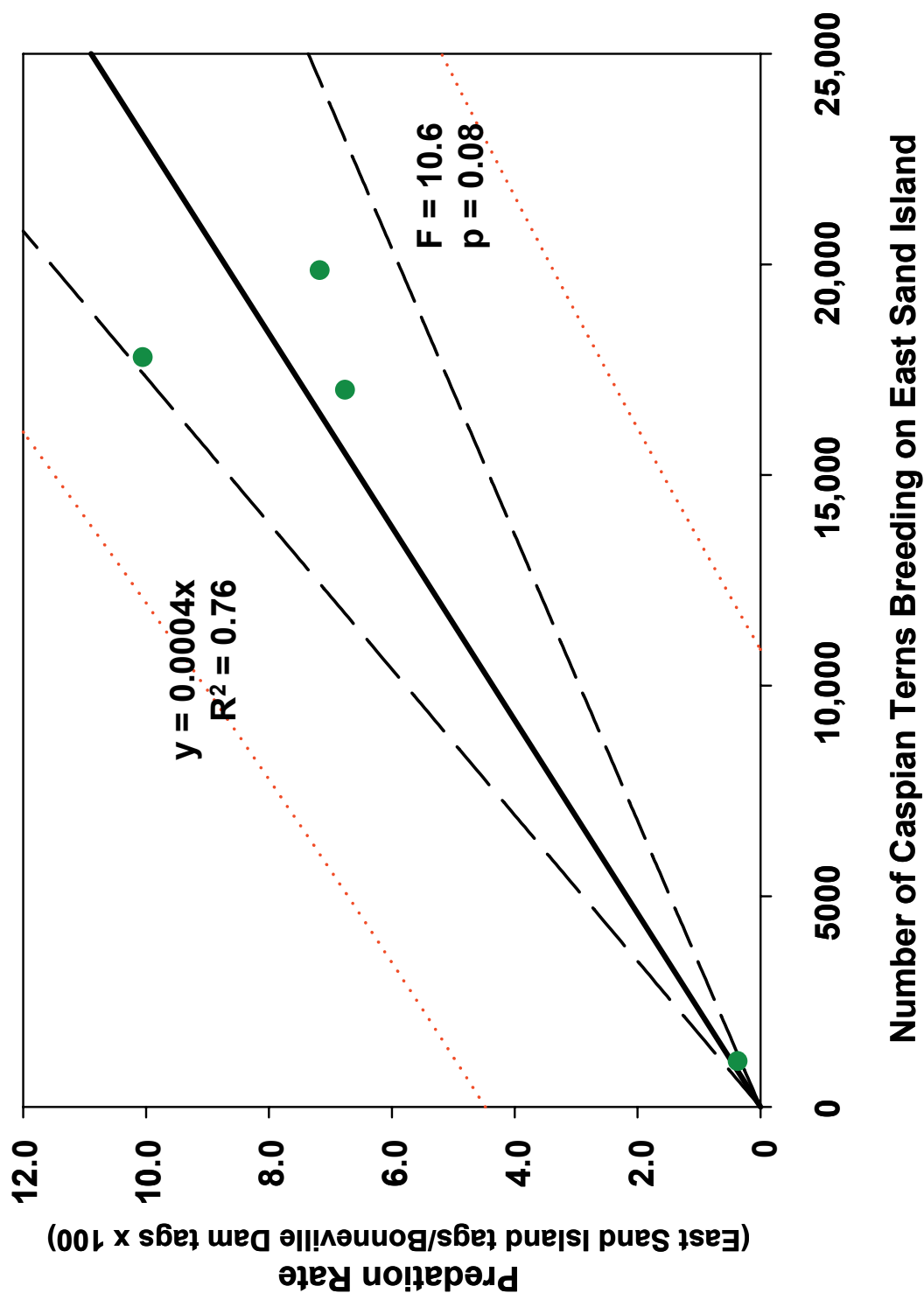


Figure 10. Linear regression of predation rates on the *Middle Columbia River steelhead ESU* in the Columbia River estuary by Caspian Terns breeding on East Sand Island (1999-2002) estimated using *recovery of PIT tags*. Dashed black lines represent 95% confidence limits; dotted red lines represent 95% prediction limits.

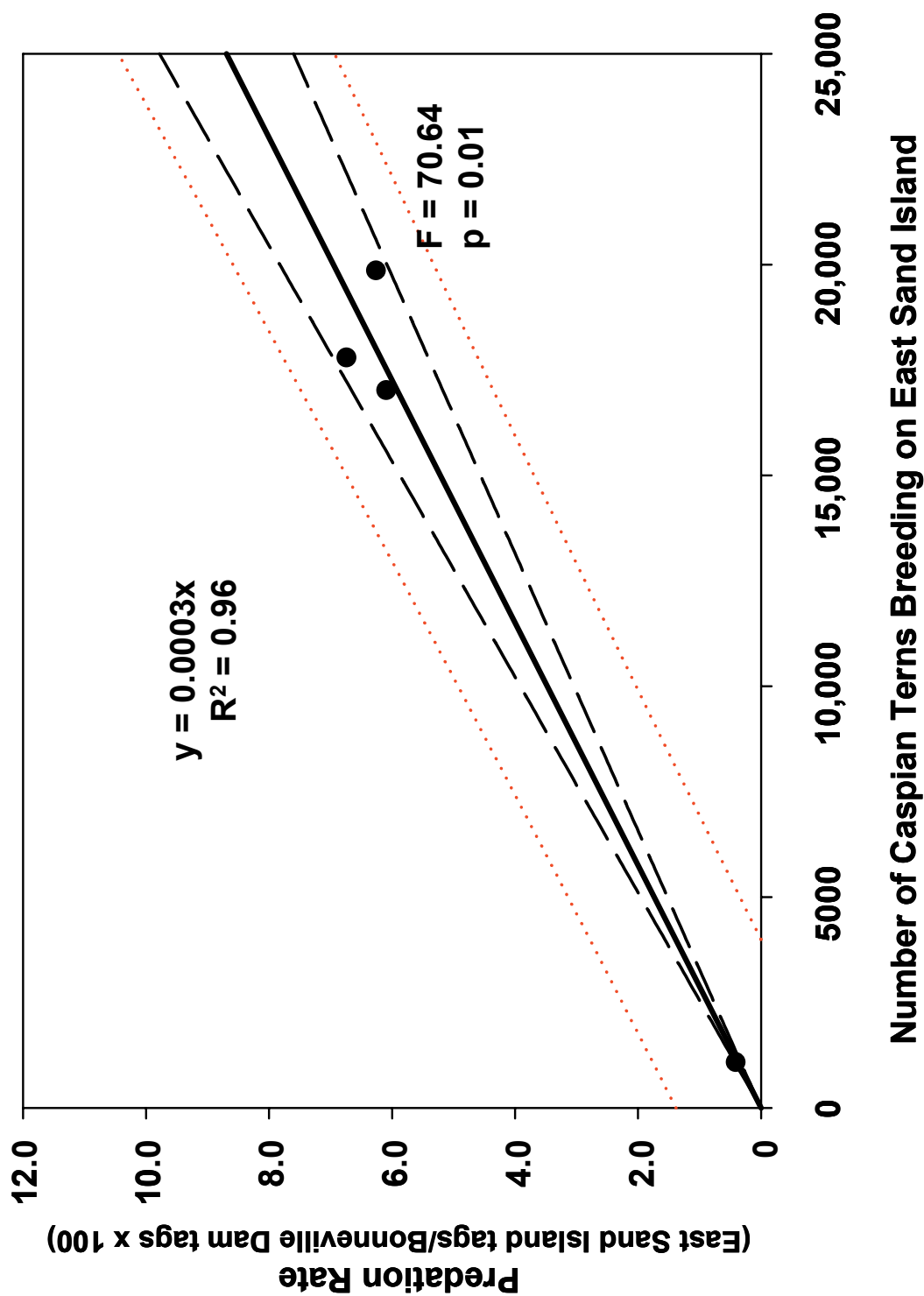


Figure 11. Linear regression of predation rates on the *Lower Columbia River steelhead ESU* in the Columbia River estuary by Caspian Terns breeding on East Sand Island (1999-2002) estimated using *recovery of PIT tags*. Dashed black lines represent 95% confidence limits; dotted red lines represent 95% prediction limits.



Appendix D. Applicable Laws and Executive Orders

Law, Regulation, or Guideline	Description
Migratory Bird Treaty Act of 1918 (MBTA), as amended, (16 U.S.C. 703-711)	The Service has the primary statutory authority to manage migratory bird populations in the United States. The MBTA implements treaties with Great Britain (for Canada in 1916 as amended in 1999), the United Mexican States (1936 as amended in 1972 and 1999), Japan (1972 as amended in 1974), and the former Soviet Union (1978) and imposed certain obligations on the U.S. for the conservation of migratory birds, including the responsibilities to: conserve and manage migratory birds internationally; sustain healthy migratory bird populations for consumptive and non-consumptive uses; and restore depleted populations of migratory birds. Conventions are also held with Mexico, Japan, and Russia.
Endangered Species Act of 1973 (ESA), as amended (7 U.S.C. 136; 16 U.S.C. 460 et seq.)	It is Federal policy, under the ESA, that all Federal agencies seek to conserve threatened and endangered species and utilize their authorities in furtherance of the purposes of the Act (Sec. 2(c)).
National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321-4347)	NEPA is our national charter for protection of the environment; it requires Federal agencies to evaluate the potential environmental impacts when planning a major Federal action and ensures that environmental information is available to public officials and citizens before decisions are made and before actions are taken. It mandates a process for thoroughly considering what an action may do to the human environment and how any adverse impacts can be mitigated (http://npi.org/nepa/process.html).
Sustainable Fisheries Act (Public Law 104-297) (re-named from the Magnuson-Stevens Act) (MSA)	Amended the habitat provisions of the MSA. It calls for direct action to stop or reverse the continued loss of fish habitats. The Act requires Federal agencies to protect, conserve, and enhance "essential fish habitat" (EFH) for federally managed fish species; "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."
Public Law 106-53, Section 582c	Requires the U.S. Army Corps of Engineers to "carry out methods to reduce nesting populations of avian predators on dredge spoil islands in the Columbia River under the jurisdiction of the Secretary" in conjunction with the Departments of Interior and Commerce.

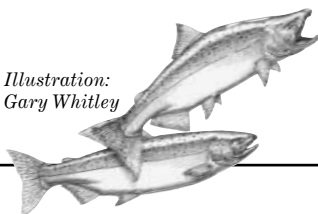
Appendix D. Applicable Laws and Executive Orders Continued

Law, Regulation, or Guideline	Description
Fishery Conservation and Management Act (FCMA) of 1976 (16 U.S.C. 1801-83)	Law 99-659, Section 104, amended Section 302 of the 1976 act requires all Federal agencies to respond within 45 days to comments and recommendations made by the Regional Fishery Management Council relative to the impacts a Federal activity have on fishery resources under the Council's jurisdiction.
Fish and Wildlife Coordination Act (FWCA) of 1958	Requires equal consideration and coordination of wildlife conservation with other water resource development programs.
Fish and Wildlife Conservation Act (16 USC 661-667e), as amended	Requires the Service to monitor non-gamebird species, identify species of management concern, and implement conservation measures to preclude the need for listing under ESA.
Fish and Wildlife Act of 1956 (16 USC 742a-743j)	Provides Secretary of Interior with authority to protect and manage fish and wildlife resources.
Executive Order 13186 (EO), Responsibilities of Federal Agencies to Protect Migratory Birds	Directs any Federal agency whose actions have a measurable negative impact on migratory bird populations to develop a Memorandum of Understanding (MOU) with the Service to promote conservation of migratory birds. The MOUs would establish protocols to guide future agency regulatory actions and policy decisions; renewal of permits, contracts or other agreements; and the creation of or revisions to land management plans.
Federal Water Pollution Control Act of 1948, as amended ("Clean Water Act")	The Clean Water Act (CWA) contains a number of provisions to restore and maintain the quality of the nation's water resources. Provides for protection of water quality.
Coastal Zone Management Act (CZMA) of 1972, as amended (16 U.S.C. 1451-1464)	Protects environmental quality of coastal areas.
Estuary Protection Act (16 U.S.C. 1221-1226)	The purpose of the Estuary Protection Act is to establish a program to protect, conserve and restore estuaries. The act does not affect an agency's authority for existing programs within an estuary.
Executive Order 11593 (EO), Protection and Enhancement of the Cultural Environment	States that if the Service proposes any development activities that may affect archeological or historical sites, the Service will consult with Federal and State Historic Preservation Officers to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

Appendix D. Applicable Laws and Executive Orders Continued

Law, Regulation, or Guideline	Description
Executive Order 12898 (EO), Federal Actions to Address Environmental Justice in Minority and Low-Income Populations, 11 February 1994	The overall purpose of the order is to avoid disproportionately high imposition of any adverse environmental or economic impacts on minority or low-income populations. All NEPA environmental analyses must include an evaluation of effects on minority and low income communities.
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	Provides a mechanism for establishing regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications.
Section 10, Rivers and Harbors Act of 1899 (30 Stat 1151; 33 USC 401 Section 10)	Provides for the protection of waters associated with work in or affecting Navigable Waters of the United States. Requires U.S. Army Corps of Engineers review for structures or work.

Illustration:
Gary Whitley



Appendix E: Distribution List

INDIVIDUALS

Ainley, David	Richards, Loretta
Alderson, George & Francis	Ruud, Mary Catherine
Babb, Evelyn	Sandall, Marilyn
Boeholt, Dan	Skumanich, Marina
Boerner, Stephen	Smith, Deborah
Bradford, Debby	Smith, Kerry
Brookman, Gerald	Swanson, Michael
Colter, Carolee	Thomas-Blake, Debra
Conroy, Edward	Williams, George
Corriere, Caryn	Winstead, Robert
Daigneault, Steve	
Davis, Shannon	
DeNiro, Liz	
Durr, Greg & Becky	
Emde, Richard	
Fatta, Louis	
Fields, Gary	
Fisher, Bruce	
Fisk, Bill	
Grant, Catherine	
Groves, Desiree	
Hamilton, Dave	
Hearn, Jim	
Hendricks, Brenda	
Hill, Brandon	
Honican, Albert	
Huhtala, Peter	
Ishiyama, D.	
Jacus, Anna	
Julius, Theresa	
Knutson, Peter	
Kocsis, Amy	
Krajewski, Dan	
Laier, Charles	
Lamb, Alexandra J.	
Larsen, Adolph	
Long, Meredith	
Malek, Robert	
Marett, Robert & Susan	
Marinkovich, Fred	
Martinson, Kahler	
Mayo, John	
McGuire, Matthew	
Miller, Bonnie	
Moon, Melanie	
Morse, Melissa	
Muller, Gretchen	
Murray, Shannon	
Norman, Donald	
O'Brien, Kim	
Parameswaran, G.	
Powers, Denise	

NAME

ORGANIZATION

ACADEMIC INSTITUTIONS

Colwell, Mark	Humboldt State University
Fischer, Karen	OSU-Columbia River Avian Predation Project
Larson, Keith	Oregon State University
Roby, Dan	Oregon State University
Schiller, Anja	Oregon State University
Shugart, Gary	Slater Museum of Natural History
Wells, Adam	OSU-Columbia River Aviation Predation Program

NON GOVERNMENT ORGANIZATIONS

(no contact name)	North Cascades Audubon Society
(no contact name)	Olympic Peninsula Audubon
(no contact name)	Humboldt Fish Action Council
(no contact name)	San Francisco Bay Chapter, Sierra Club
(no contact name)	Oregon Chapter, Sierra Club
(no contact name)	Cascade Chapter, Sierra Club
(no contact name)	Oregon Environmental Council
(no contact name)	Audubon Society - Redwood Region
(no contact name)	National Audubon Society
(no contact name)	NW Steelhead/Salmon Council of Trout Unlimited
(no contact name)	Westport Charter Fisherman's Association
(no contact name)	Washington Trout
(no contact name)	Northwest Sportfishing Industry & Association
(no contact name)	Sea and Sage Audubon
(no contact name)	The Nature Conservancy
(no contact name)	California Sportfishing Coalition
(no contact name)	California Sportfishing Protection Alliance
(no contact name)	American Rivers Society
(no contact name)	Golden Gate Audubon
(no contact name)	Santa Clara Audubon
(no contact name)	Napa Solano Audubon
(no contact name)	Trout Unlimited
(no contact name)	Columbia River Keeper
(no contact name)	Marin Conservation League
(no contact name)	National Audubon
(no contact name)	Sequoia Audubon
(no contact name)	Fisherman's Marketing Association
Allen, Brian	Columbia Basin Fish & Wildlife Authority
Ambroge, Christina	EPIC
Bakke, Bill	Native Fish Society
Barber, Harry	Lower Columbia Fish Enhancement Group
Beaty, Roy	Fish Commission
Berggren, Steve	Resource Coalition and Commercial
Burns, Keith	Gray Harbor Poggie Club
Cedergreen, Mark	Westport Charterboat Association
Clark, Tom	Lower Columbia Basin Audubon
Cochlin, Clyde	E. Washington Steelhead Foundation
Cohen, Ellie	PRBO Conservation Science
Croonquist, David	Puget Sound Anglers

NAME

ORGANIZATION

NON GOVERNMENT ORGANIZATIONS (CONTINUED)

Curl, Jr, Herbert	Seattle Audubon Society
Eaton, Bob	Salmon for All
Englemeyer, Paul	National Audubon Society
Eversen, John	Steelhead Trout Club of Washington
Fee, Sharnelle	Wildlife Rehab Center of the North Coast
Feinstein, Arthur	Golden Gate Audubon/CCCR
Fricke, Doug	Chehalis Basin Fisheries Task Force
Grunbaum, Arthur (R.D)	Friends of Grays Harbor
Hanson, Janet	San Francisco Bay Bird Observatory
Harrison, Craig	Pacific Seabird Group
Heiken, Doug	Oregon Natural Resources Council
Hoppler, Wes	Steelhead Trout Club of Washington
Jacobsen, Jim	USACE-Seattle
Jones, Tod	CEDC Fisheries
Kennedy, Caroline	Defenders of Wildlife
Ketcham, Paul	Audubon Society of Portland
Kress, Stephen	Seabird Restoration Program
LePage, Al	National Coast Trail Associations
LeValley, Ron	Mad River Biologists
Mantua, Nathan	Wild Steelhead Coalition
McRoberts, James	Federation of Fly Fishers
Mills, Kyra	PRBO Conservation Science
Morgan, Alex	Seattle Audubon
Mueller, Dana	Eastern Washington Steelhead Foundation
Nelson, Ray	Lahontan Audubon Society
Packard, Heath	Audubon Washington and Black Hills Audubon
Perciasepe, Bob	National Audubon Society
Puddicombe, Steve	Willapa Hills Audubon
Rolfe, Allison	San Diego Audubon Society
Schoyen, Kris	Washington State Audubon
Schwickerath, Dean and Dianne	Grays Harbor Audubon Society
Senatore, Mike	Defenders of Wildlife
Shaffner, Owen	SW WA County Farm Bureau
Sikes, Ron	Admiralty Audubon Chapter
Soverel, Peter	Wild Salmon Center
Spain, Glen	Pacific Coast Federation of Fishermen's Assoc.
Strake, Gretchen	Vancouver Audubon Society
Strong, Cheryl	San Francisco Bay Bird Observatory
Tingley, Ron	Wildcat Steelhead Club
Turner, Terry	Washington Council of Trout Unlimited
Twitchell, Marilyn	National Audubon Society
Wahl, Leslie	Yakima Valley Audubon Society
Whitworth, Joe	Oregon Trout
Winegrad, Gerald	American Bird Conservation

BUSINESS

Blanchard, Cecil	Columbia River Fisherman's Protective Union
Brewer, Rone	SafeHarbor Technology Corporation
Collis, Ken	Landau Associates Inc.
Cook, Bill	Real Time Research
	Port of Astoria

NAME	ORGANIZATION
BUSINESS (CONTINUED)	
Meier, Robert	Rayonier Technical Services
Mitby, Eric	
Nelson Crab Inc	
Rauzon, Mark	Marine Endeavors
MEDIA	
Crampton, Bill	Columbia Basin Bulletin
Espenson, Barry	Columbia Basin Bulletin
Loney, Terry	The Daily World
CITY AGENCIES & GROUPS	
(no contact name)	Port of Chinook
(no contact name)	City of Arcata
(no contact name)	City of Eureka
Andrews, Ryan	City of Westport
Kavanaugh-Lynch, Maragret	City of Alameda Planning and Building
McNerney, John T.	City of Davis, Public Works
COUNTY AGENCIES & GROUPS	
Beerbower, Bob	Pacific County Commissioners Courthouse
Bobzien, Steve	Grays Harbor County Board of Commissioners
Carter, Albert	East Bay Regional Park District
Cervelli, Ann	District #3
Chapman, Michael	Contra Costa County Board of Supervisors
Conlon, Thomas	Clallam County Commissioner
Doherty, Mike	Humboldt County Planning Department
Hishida, Crystal	Clallam County Commissioner
Huntingford, Glen	Alameda County Board of Supervisors
Leong, Eugene	Jefferson County Commissioner
Maltbie, John	Association of Bay Governments
McGoldrick, Jake	San Mateo County Board of Supervisors
Morrisette, Dennis	San Francisco Board of Supervisors District 1
Palmer, Andy	Grays Harbor County Board of Commissioners
Perez-Sorensen, Phyllis	Jefferson County Marine Resource Company
Pock, Darrel	Santa Clara County Board of Supervisors
Schmitt, Joe	Grant County PUD
Tharinger, Stephen	Clallam County Marine Resource Company
	Clallam County Commissioner
STATE AGENCIES & GROUPS	
Ball, Lindsay	Washington Environmental Council
Beach, Rocky	Oregon Department of Fish and Wildlife
Bean, Dave	Washington Department of Fish and Wildlife
Burkett, Esther	Washington Department of Natural Resources
Caswell, James	California Department of Fish and Game
	State of Idaho Office of Species Conservation

NAME

ORGANIZATION

STATE AGENCIES & GROUPS CONTINUED

Crawforth, Terry
Dobler, Fred
Frey, Vicki
Hampton, Steve
Huffaker, Steve
Koenings, Jeff
Neel, Larry
Nichols, Mary
Pustis, Nancy
Rea, Maria
Sallabanks, Rex
Schnebly, Shan
Smith, Jack
Stone, Richard
Warren, Ron
Wood, Dan
Zora, Craig

Nevada Department of Wildlife
Washington Department of Fish & Wildlife
California Department of Fish and Game
Office of Spill Prevention and Response CDFG
Idaho Department of Fish and Game
Washington Dept. of Fish and Wildlife
Nevada Department of Wildlife
CA Resources Agency
Oregon Division of State Lands
CA Resource Agency - Salmon & Watershed
Idaho Fish and Game Department
WSFB
Washington Department of Fish and Wildlife
Washington Department of Fish and Wildlife
Washington Department of Fish and Wildlife
Farm Bureau
Washington Department of Natural Resources

TRIBAL GOVERNMENTS & STAFFS

Allen, W. Ron
Anderson, Jim
Brunoe, Garland
Burke, Gary
Capoeman-Baller, Pearl
Charles, Ronald
Crombie, Howard
Hapner, Nina
James, Gordon
Jim, Russell
Johnson, Anthony
Kennedy, Cheryle
McCullough, Dale
Meninick, Jerry
Nation
Nelson, Charlene
Pigsley, Delores
Sullivan, Dennis

Northwest Indian Fisheries Commission
Jamestown S'Klallam Tribal Council
Northwest Indian Fisheries Commission
Conf. Tribes of the Warm Springs Reservation
Confederated Tribes of the Umatilla Indian Resv.
Quinalt Indian Nation-Business Committee
Port Gamble S'Klallam Tribe
Conf. Tribes of Coos, Lower Umpqua & Siuslaw
Table Bluff Reservation Wiyot Tribe
Skokomish Tribal Council
Conf. Tribes & Bands of the Yakama Indian Nation
NPTEC, Nez Perce Tribe
Confederated Tribes of the Grande Ronde
Columbia River Inter-Tribal Fish Commission
Conf. Tribes & Bands of the Yakama Indian

Shoalwater Bay Tribal Council
Confederated Tribes of Siletz Indians
Lower Elwha Klallam Tribe

FEDERAL AGENCIES & OFFICES

(no contact name)
(no contact name)
(no contact name)
(no contact name)
(no contact name)
(no contact name)
(no contact name)
(no contact name)

Klamath Basin NWRC
Sacramento/San Joaquin Estuary FRO
San Diego NWR
Upper Columbia River Basin Fisheries Office
Cultural Resource Team, Sherwood, Oregon
San Pablo Bay NWR
California/Nevada Operations Office
Oregon Coast NWRC

NAME

ORGANIZATION

FEDERAL AGENCIES & OFFICES (CONTINUED)

(no contact name)	Sonny Bono Salton Sea NWRC
(no contact name)	Modoc NWRC
(no contact name)	United States Fish and Wildlife Service
(no contact name)	Malhuer NWRC
(no contact name)	Malhuer NWRC
(no contact name)	Mid Columbia NWRC
(no contact name)	Southeast Idaho NWRC
(no contact name)	Minidoka NWRC
(no contact name)	Stillwater National Wildlife Refuge Complex
(no contact name)	Oregon State Office
(no contact name)	Columbia Basin Ecoregion
Adelsbach, Terry	Sacramento Fish and Wildlife Office
Berg, Ken	Western Washington Fish and Wildlife Office
Bohan, Carolyn	National Wildlife Refuge System
Cameron, Forrest	National Wildlife Refuge System
Concannon, Julie	U.S. Fish and Wildlife Service, Regional One
Diggs, Daniel	U.S. Fish and Wildlife Service, Region One
Dunmire, Scott	USCOE, Walla Walla District Office
Gibbons, Jason	USDA-APHIS Wildlife Services
Kolar, Margaret	San Francisco Bay NWRC
Marker, Doug	Northwest Power Planning Council
Maslen, Bill	Bonneville Power Administration
McChesney, Gerry	San Francisco Bay National Wildlife Refuge
McQuillen, Harry	Sacramento Fish and Wildlife Office
Nelson, Eric	Humboldt Wildlife Refuge
Olney, Fred	U.S. Fish and Wildlife Service, Region One
Paulin, Dave	Klamath and Central Valley/San Francisco Bay
Roush, Linda	Arcata Resource Area, BLM
Ryan, Kevin	Washington Maritime NWRC
Schlafmann, Deb	Habitat Conservation and Partners
Selvaggio, Sharon	U.S. Fish and Wildlife Service
Shake, Bill	U.S. Fish and Wildlife Service, Regional One
Stenvall, Charlie	Willapa NWRC
Swan, Ron	U.S. Fish and Wildlife Service, Regional One
Takekawa, Jean	Nisqually NWR
Thompson, Steve	California/Nevada Operations Office
Wagne, Kim	USDA/APHIS/COS
Walsworth, Dan	Nevada/Southern California-CNO Sacramento
Waters, Linda	North Pacific Coast/Pacific Islands Ecoregion
Welch, Dorie W.	Bonneville Power Administration
Wesley, Dave	United States Fish and Wildlife Service
Wills, David	R1 Columbia River Fisheries Program Office
Wilson, Paul	Columbia River Fisheries Program Office

STATE LEGISLATURE

Dukes, Joan	Member of Congress
Blake, Brian	Member of Congress
Butler, Tom	Member of Congress
Canciamilla, Joesph	Member of Congress
Doumit, Mark	Member of Congress

NAME

ORGANIZATION

STATE LEGISLATURE (CONTINUED)

Figueroa, Liz	Member of Congress
Guinn, Kenny	Governor of Nevada
Hatfield, Brian	Member of Congress
Kempthorne, Dick	Governor of Idaho
Kulongoski, Ted	Governor of Oregon
Locke, Gary	Governor of Washington
McPherson, Ruce	Member of Congress
Merkle, Jeff	Member of Congress
Perata, Don	Member of Congress
Schwarzenegger, Arnold	Governor of California
Sher, Byron	Member of Congress
Speier, Jackie	Member of Congress
Stark, Fortney "Pete"	Member of Congress
Tauscher, Ellen	Member of Congress
Vasconcellos, John	Member of Congress
Yee, Ph.D., Leland	Member of Congress

US CONGRESS

Baird, Brian	Member of Congress
Boxer, Barbara	Member of Congress
Cantwell, Maria	Member of Congress
Craig, Larry E.	Member of Congress
Crapo, Mike	Member of Congress
Dicks, Norm	Member of Congress
Eshoo, Anna	Member of Congress
Feinstein, Dianne	Member of Congress
Ferrioli, Ted	Member of Congress
Gibbons, James	Member of Congress
Honda, Michael	Member of Congress
Kitts, Derrick	Member of Congress
Lantos, Tom	Member of Congress
Lee, Barbara	Member of Congress
Lofgren, Zoe	Member of Congress
Miller, George	Member of Congress
Murray, Patty	Member of Congress
Pelosi, Nancy	Member of Congress
Reid, Harry	Member of Congress
Rusigh, John	Member of Congress
Simpson, Mike	Member of Congress
Smith, Gordon	Member of Congress
Walden, Greg	Member of Congress
Wu, David	Member of Congress
Wyden, Ron	Member of Congress



Appendix F: Caspian Tern Regional Population Nesting Site Locations and Colony Sizes

TABLE F.1 Current and Historic Caspian Tern Nesting Locations in the Pacific Coast Region

Site Location	Current ^a	Historic ^b
WASHINGTON		
Dungeness Spit NWR, Clallam County	x	
Padilla Bay, Skagit County		x
Commencement Bay, Pierce County	x ^c	
Grays Harbor, Grays Harbor County		x
Willapa Bay, Pacific County		x
Miller Rocks, Klickitat County		x
Crescent Island, Walla Walla County	x	
Banks Lake, Grant County	x	
Potholes Reservoir, Grant County	x	
Sprague Lake, Adams County	x	
OREGON		
East Sand Island, Clatsop County	x	
Rice Island, Clatsop County	x ^d	
Miller Sands Spit, Clatsop County		x ^d
Threemile Canyon Island, Morrow County	x ^e	
Malheur Lake, Harney County	x	
Crump Lake, Lake County	x	
Summer Lake, Lake County	x	
CALIFORNIA		
Humboldt Bay, Humboldt County	x	
Knights Island, Solano County	x	
Brooks Island, Contra Costa County	x	
Agua Vista, San Francisco County	x	
Hayward Regional Shoreline, Alameda County	x	
Bair Island, San Mateo County	x	
Ravenswood, San Mateo County	x	
Proposed Alameda NWR, Alameda County	x ^f	
Baumberg Tract, Alameda County	x	
Ponds M4/M5, Alameda County		x
Ponds N1-N9, Alameda County		x
Alviso (Pond A7), Santa Clara County	x	
Elkhorn Slough, Monterey County	x	
Salinas River NWR, Monterey County	x	
Bolsa Chica Ecological Reserve, Orange County	x	
Pier 400, Terminal Island, Los Angeles County	x	
South San Diego Bay NWR, San Diego County	x	
Meiss Lake, Butte Valley WA, Siskiyou County	x	
Clear Lake NWR, Modoc County	x	
Goose Lake, Modoc County	x	
Big Sage Reservoir, Modoc County	x	
Honey Lake WA, Lassen County	x	
Mono Lake, Mono County	x	
Lemoore NAS sewer ponds, Kings County	x	
Westlake Farms North Evaporation Ponds, Kings County	x	
Westlake Farms South Evaporation Basin, Kings County	x	
Tulare lakebed, Kings County	x	
South Wilbur Flood Area, Kings County	x	
Tulare Lake Drainage District, North Evaporation Basin, Kings County	x	
Tulare Lake Drainage District, South Evaporation Basin, Kings and Kern County	x	
Lake Elsinore, Riverside County	x	
Salton Sea, Imperial County	x	

Appendix F: Caspian Tern Regional Population Nesting Site Locations and Colony Sizes Continued

TABLE F.1 Current and Historic Caspian Tern Nesting Locations in the Pacific Coast Region (continued)

Site Location	Current ^a	Historic ^b
MEXICO		
Cerro Prieto, Mexicali Valley	x	
Isla Montague	x	
Isla Concha	x	
Isla Vaso 8	x	
IDAHO		
Mormon Reservoir, Camas County	x	
Magic Reservoir, Blaine County		x
Minidoka NWR, Cassia County	x	
American Falls Reservoir, Bingham County	x	
Blackfoot Reservoir, Caribou County	x	
Bear Lake NWR, Franklin County		x
NEVADA		
Stillwater Point Reservoir, Churchill County		x
Lahontan Reservoir, Lyon County		x
Carson Sink, Churchill County	x	
Anaho Island NWR, Washoe County	x	
UTAH		
Great Salt Lake, Tooele County		x
Bear River Migratory Bird Refuge, Box Elder County		x
Farmington Bay Waterfowl Management Area, Davis County		x
Utah Lake, Utah County		x
MONTANA		
Canyon Lake Ferry Reservoir, Lewis and Clark Counties	x	
Fort Peck Reservoir, Charles M. Russell NWR, Valley County	x	
WYOMING		
Molly Island, Yellowstone National Park	x	
Pathfinder Reservoir, Natrona and Carbon Counties		x
Soda Lake Islands, Natrona County	x	
Gray Reef Reservoir, Natrona County		x
Bamforth Lake, Albany County		x
Caldwell Lake, Albany County		x

^a Active nesting occurred at these sites in the last 5 years. Nesting may or may not have occurred in 2003.

^b Nesting activity has not occurred for the last 5 consecutive years.

^c Colony last nested in 2002 but site is no longer available because of environmental clean-up.

^d Terns could potentially nest at these locations, but active management actions are being implemented to prevent terns from nesting.

^e Mink predation occurred at this site in 2001 and most likely will inhibit any future nesting activity.

^f Nesting habitat was lost to heavy vegetation in 1999; restoration needs to occur before terns are able to nest again.

Appendix F: Caspian Tern Regional Population Nesting Site Locations and Colony Sizes Continued

TABLE F.2 Caspian Tern Pacific Coast Regional Population, 1997 to 2003 and Average Colony Size^a

Site Location	Number of Nesting Pairs							Average ^b Colony Size
	1997	1998	1999	2000	2001	2002	2003	
WASHINGTON								
Dungeness NWR							186 ^c	-
Padilla Bay	0	0	-	-	-	-	0	104 ^d
Commencement Bay	-	-	423	620 ^e	388	215 ^e	0	412
Grays Harbor	0	0	0	0	0	0	0	1675 ^f
Willapa Bay	0	0	0	0	0	0	0	820 ^g
Miller Rocks	-	-	-	-	15	0	0	-
Crescent Island	614 ^c	357 ^c	552 ^c	548	657	578	509	545
Banks Lake	-	-	-	10	23	-	21	18
Potholes Reservoir	259	-	-	150	~250	~250	205	223
Sprague Lake	-	-	~50	20	20	-	-	30
OREGON								
East Sand Island	0	0	547	8,513	8,896	9,933 ^h	8,352 ^h	7,248
Rice Island	7,151	8,691	8,328	588	0	0	0	6,190
Miller Sands Spit	0	17	0	0	0	0	0	-
Threemile Canyon Island	354 ^c	210 ^c	238 ^c	260	2	0	0	266 ⁱ
Malheur Lake	65	25	30	192 ^c	51 ^c	0	0	73
Crump Lake	-	-	-	155 ^c	-	0	49	102
Summer Lake	-	-	38	16	0	~5	5	16
CALIFORNIA								
Humboldt Bay	-	-	-	-	~17 ^c	~6 ^c	60 ^c	28
Knights Island	400	~200	-	121 ^c	43 ^c	153	203	187
Brooks Island	~500	582	Active	806 ^c	512 ^c	825	859	681
Agua Vista	-	-	-	-	-	86 ^c	43 ^c	65
Hayward Regional Shoreline	1	1	1	1	1	1	0	1
Ravenswood	0	4	0	1	1	1	0	1
Alameda	285	267	1	0	0	0	0	184
Baumberg Tract	0	33	26	79	116	80	35	62
Alviso (Pond A7)	104	30	122	118	155	73	50	93
Elkhorn Slough	0	0	~30	~80	~65	~50	~50	~55
Salinas River NWR	-	-	-	-	2	93 ^c	167	87
Bolsa Chica ^j	175	40	58	51	92	192	5	613
Pier 400, Terminal Island	25	146	250	336	160	151	170	177
South San Diego Bay NWR	320	198	261	380	350	379	311	314
Meiss Lake, Butte Valley WA	25 ^c	16	27	19	0	0	0	22
Clear Lake NWR	180 ^c	68 ^c	118	242 ^c	201	0	29	120
Goose Lake	143 ^c	-	310 ^c	4	~240	133	282	185
Big Sage Reservoir	62 ^c	-	0	48	0	0	0	55
Honey Lake WA	152	-	87	82	92	46	13	79
Mono Lake	0	0	0	8	6	11	8	8
Lemoore NAS sewer ponds	-	20 ^c	0	-	-	0	-	-
Westlake Farms, South Evaporation Basin	0	3	0	0	0	0	-	-
Tulare lakebed	0	20 ^c	0	0	0	0	-	-
South Wilbur Flood Area	0	70	27	0	0	0	-	49
Tulare Lake Drainage District, North Evaporation Basin	0	0	0	0	1	0	-	-
Tulare Lake Drainage District, South Evaporation Basin	0	40	0	0	0	0	-	-
Lake Elsinore	-	-	14	-	-	0	-	-
Salton Sea	1,200	800	211	207	327	29	88	409

Appendix F: Caspian Tern Regional Population Nesting Site Locations and Colony Sizes Continued

TABLE F.2 Caspian Tern Pacific Coast Regional Population, 1997 to 2003 and Average Colony Size^a

Site Location	Number of Nesting Pairs							Average ^b Colony Size
	1997	1998	1999	2000	2001	2002	2003	
MEXICO								
Cerro Prieto	30	-	-	0	0	4	37	-
Isla Montague	-	-	-	-	-	83	-	-
Isla Concha	-	-	-	-	-	21	23	22
Isla Vaso 8	-	-	-	-	-	32	90	61
IDAHO								
Mormon Reservoir	-	-	-	-	~2	25	0	14
Minidoka NWR	-	-	-	1	0	4	0	1
American Falls Reservoir	-	-	-	-	-	5	0	-
Blackfoot Reservoir	-	-	-	-	0	50	40	45
NEVADA								
Carson Sink	0	-	685	0	0	0	0	-
Anaho Island NWR, Pyramid Lake	1	5	0	0	0	0	5	4
MONTANA								
Canyon Lake Ferry Reservoir	5	0	2	7	35	43	11	15
Fort Peck Reservoir, Charles M. Russell NWR	?	?	?	?	~25	~25	-	25
WYOMING								
Molly Island, Yellowstone Lake	4	5	4	0	3	5	-	4
Soda Lake islands	0	0	0	7	12	19	-	13
PACIFIC REGION TOTALS ^k	12,115	11,848	12,440	13,669	12,760	13,606	11,906	-

^a Data from Shuford and Craig 2002 with additional data for 2002 and 2003 from USFWS and D. Shuford. To enable estimation of the total numbers of breeding pairs in the entire region, we adjusted some raw counts or estimates. When a range was given for numbers of nests or pairs we report the mid-point (e.g., 800-850 pairs reported as 825 pairs) and for breeding adults we use the mid-point as the basis for estimating numbers of pairs. Counts or estimates of breeding adults were multiplied by 0.62 to approximately estimate numbers of breeding pairs based on the average ratio of nests to adults at sites on the California coast (0.625, Carter et al. 1992, p. I-45) and the California interior (0.61, D. Shuford unpubl. data). Dashes (-) indicate that no survey was conducted or no data available, zeroes (0) that a survey was conducted but no evidence of nesting observed, and question marks (?) that nesting strongly suspected but no solid data available.

^b Average colony size was based on years with nest counts only.

^c Counts of adults were converted to an estimate of breeding pairs by multiplying raw adults by the 0.62 correction factor described above.

^d Average colony size for Padilla Bay was calculated based on data collected in 1991 and 1995 (M. Davison pers. comm)

^e Counts of adults were converted to an estimate of breeding pairs by multiplying raw adults by the 0.62 correction factor described above. Terns at Commencement Bay in 2002 were nesting on the rooftop of a Port of Tacoma building (# 407); the count of adults on which the estimate of pairs was made was taken late in the nesting season (9 July).

^f Average colony size calculated from data in Shuford and Craig (2002). Range = 9 - 3950 breeding pairs

^g Average colony size calculated from data in Shuford and Craig (2002). Range = 175 - 1500 breeding pairs

^h Data from Collis et al. 2003a and 2003b

ⁱ Average colony size does not include 2001 nest count because the colony was affected by a predator that year.

^j All counts from Bolsa Chica are of total nest attempts (on the basis of marked nests), which likely overestimates nesting pairs because of pairs that re-nest after initial failures.

^k Totals are likely underestimates because of a lack of surveys at some sites in particular years or during the whole time period (e.g., most sites in Mexico).

Appendix G: Potential Caspian Tern Nesting Sites in the Pacific Coast Region: Selection Process and Proposed Management Actions

The process used to identify the seven sites in this DEIS consisted of an initial review (feasibility assessment) of Caspian tern nesting habitat that was conducted by the Service in 2002 (see Seto et al. 2003 for full report). A total of 77 individual historic, current, and potential nesting sites (sites with appropriate habitat) in Washington, Oregon, California, Idaho, and Nevada were evaluated in this study (including site visits) to determine their management potential for Caspian terns (Seto et al. 2003). Sites in or near the Columbia River, such as Crescent Island, were eliminated from consideration because specific activities to enhance Caspian tern colonies in these locations would not contribute to the goal of reducing impacts to ESA-listed Columbia River salmonids. During the feasibility assessment, a site was determined to have management potential for Caspian terns if the following conditions were met (Seto et al. 2003, Table G.1):

1. Suitable nesting habitat is present or habitat enhancement requirements are minimal,
2. Site is available or could be managed for nesting terns every year,
3. Site can support a substantial number of breeding terns (350 to 2,000 nesting pairs),
4. Prey is available in most or all years,
5. Potential predators (mammalian and avian) are absent or controllable, and
6. Levels of natural or human disturbance are absent, minimal, or controllable.

Sites determined to have management potential for Caspian terns were also ranked to identify those sites which had the best potential to serve as alternate nesting habitat for terns displaced from East Sand Island (Tables G.2 and G.3). Based on this initial review, further investigation of sites, public scoping, and comments received by the states of Washington, Oregon, and California, the list of potential nesting sites for displaced Caspian terns was refined for analysis in this DEIS. A few sites not discussed in the feasibility assessment (e.g. Dungeness National Wildlife Refuge (NWR), Yolo Bypass Wildlife Area, and City of Davis Wetlands) were identified during scoping.

Although these sites were identified as having potential for Caspian tern management, some sites were eliminated from further consideration in this EIS (See Table G.4 for a summary of nesting

sites that were not selected and the reason for elimination). These included socio-political and biological concerns expressed by Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), California Fish and Game (CDFG), and the Service's California/Nevada Operations office. For example, several sites in coastal Washington (e.g., Grays Harbor and Padilla Bay) were identified in the feasibility assessment (Seto et al. 2003, Table G.1) as having high management potential for development of tern nesting habitat, but have been eliminated from further consideration because WDFW does not support or would not facilitate the managed relocation of Caspian terns within Washington. Since Caspian terns established a colony at Dungeness NWR in 2003 on their own accord, this site remained in our analysis.

ODFW will not support managed relocation of Caspian terns to non-historic nesting sites in Oregon. Since terns have not been documented to nest on the Oregon Coast, sites on the coast that were identified in the feasibility assessment were eliminated from further consideration (Seto et al. 2003, Table G.1). Crump and Summer lakes, although identified as having no management potential in the feasibility assessment, are included in the DEIS at the request of ODFW because they are historic or current nesting sites. Although Fern Ridge Lake is not a historic tern nesting site in Oregon, we included Fern Ridge Lake in our analysis. The Willamette and McKenzie rivers are about 15 miles from the area and since a variety of resident fish species are present in the lake, we do not expect ESA-listed salmonids to serve as a primary food resource for the terns. Thus, although this is not a historic tern nesting site, relocation of terns to this site may not result in high levels of predation on other salmonid stocks.

Similarly, CDFG will support Caspian tern management in California only at historic colonies. Therefore, although the scoping process of this EIS identified development of tern nesting habitat at the Yolo Bypass Wildlife Area and City of Davis Wetlands in the Sacramento Valley, these sites were removed from further analysis because they are not historical Caspian tern nesting sites. Additionally, although Humboldt Bay is a historic tern nesting site, Teal Island in the Humboldt Bay National Wildlife Refuge (NWR) was eliminated from further consideration in this EIS because of concerns

expressed by CDFG and the Service's California/Nevada Operations office about the potential impact of tern predation on ESA-listed salmonids and partnership efforts associated with salmon recovery. Although management actions associated with this EIS are not proposed for these sites, displaced Caspian terns may select to nest on these sites or any other sites in the region by their own accord.

Final criteria used to identify potential nesting sites listed in Table 2.1 included:

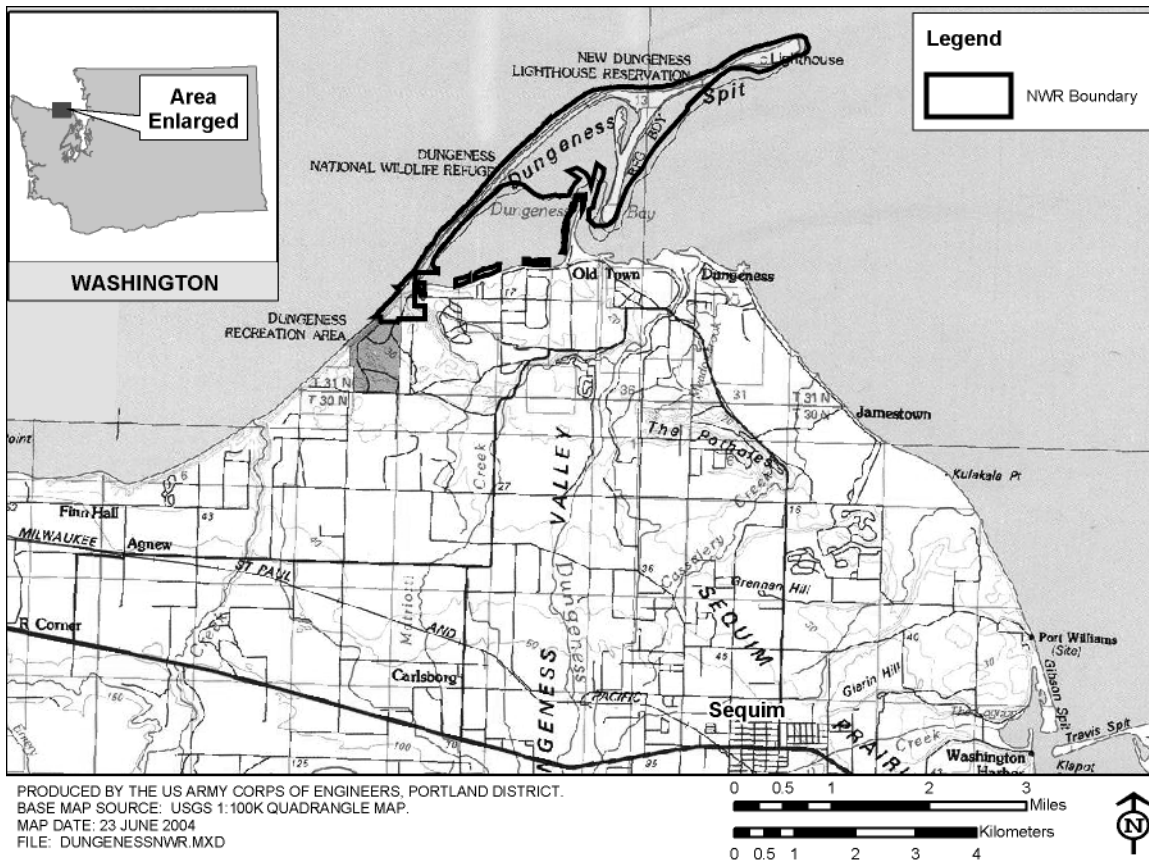
1. Relative stability and abundance of suitable prey (i.e., prey are heavily dependent on annual water levels at interior sites vs. sites with more stable water/prey resources),
2. Availability of or capability to improve/develop Caspian tern nesting habitat in the near future (2005 to 2008),
3. Ability to attract nesting terns from East Sand Island (using distance from East Sand Island as an indicator), and,
4. Minimal conflict with ESA-listed species.

Potential Caspian Tern Nesting Sites and Possible Management Actions

Management actions that would be required at each potential site if selected for implementation are described below and summarized in Table 2.1.

Dungeness NWR. Since the completion of the feasibility assessment report, a new site, Dungeness NWR (Figure G.1), in northwestern Washington, became available for consideration because terns established a new nesting colony there in 2003. The current Caspian tern nesting site at Dungeness NWR could accommodate an increased number of nesting terns and thus, does not require any habitat enhancement. However, protecting this newly established Caspian tern colony to decrease possible human disturbance and predator access would provide a secure nesting site less susceptible to factors that would otherwise lead to site failure or abandonment. This includes adding educational signs to notify visiting public of the existing closed area, enforcing closures, and monitoring predator activity. If predators, primarily mammalian, become

FIGURE G.1 Dungeness National Wildlife Refuge (NWR), Washington



a problem, a predator management program may be considered to ensure successful tern nesting. However, the control or elimination of predators may not be feasible because this site is connected to the mainland, unlike an island site which has limited predator access.

Estimated costs: \$ 65,000.00 (first year costs, including monitoring)

Crump Lake. Management actions proposed at Crump Lake (Figure G.2), in south-central Oregon, are extensive. Since the reconstructed nesting island (Crump Island) lies below full lake water levels and is subject to erosion, we propose to build up the island to an elevation that would remain above high water levels. This would be achieved by using a “mudcat” hydraulic dredge to place material from the lakebed to form the island. An interlocking, plastic sheet pile wall would be used around the island to hold the dredged material in place. These activities would occur during the month of June when water levels would be at their highest. To stabilize the surface of the constructed island (1.5 acres) and to reduce the risk of dense vegetation encroachment, the island would be capped with gravel and fines. This material would need to be placed on site via helicopter. Social attraction techniques using decoys and vocalization recordings

would be used to attract terns to nest at the new island site.

Estimated costs: \$ 1,192,413.00 (first year costs, including construction and monitoring)

Summer Lake. The historic Caspian tern nesting island in Summer Lake (Figure G.3), also in south-central Oregon, is connected to the mainland during low water years, resulting in increased vulnerability to predators. Since it would be difficult to ensure that this island remains isolated during low water level years, we propose to build new islands in wetland impoundments north of Summer Lake within the ODFW Wildlife Management Area. Proposed management actions for the Summer Lake Wildlife Management Area would occur at the East Link impoundment, and adjacent to the Windbreak and Gold Dike locations. ODFW personnel have better control of the water in these impoundments. Thus, they would serve as higher quality and more predictable habitat for Caspian terns. The East Link location is a diked, rectangular impoundment that would need to be allowed to dry in late November-early December to allow for a late July to September construction period. A 0.5 acre island would be constructed at this site, centered in the unit. Material for the island will come from either of two methods. If site conditions are suitable,

FIGURE G.2 Crump Lake, Oregon

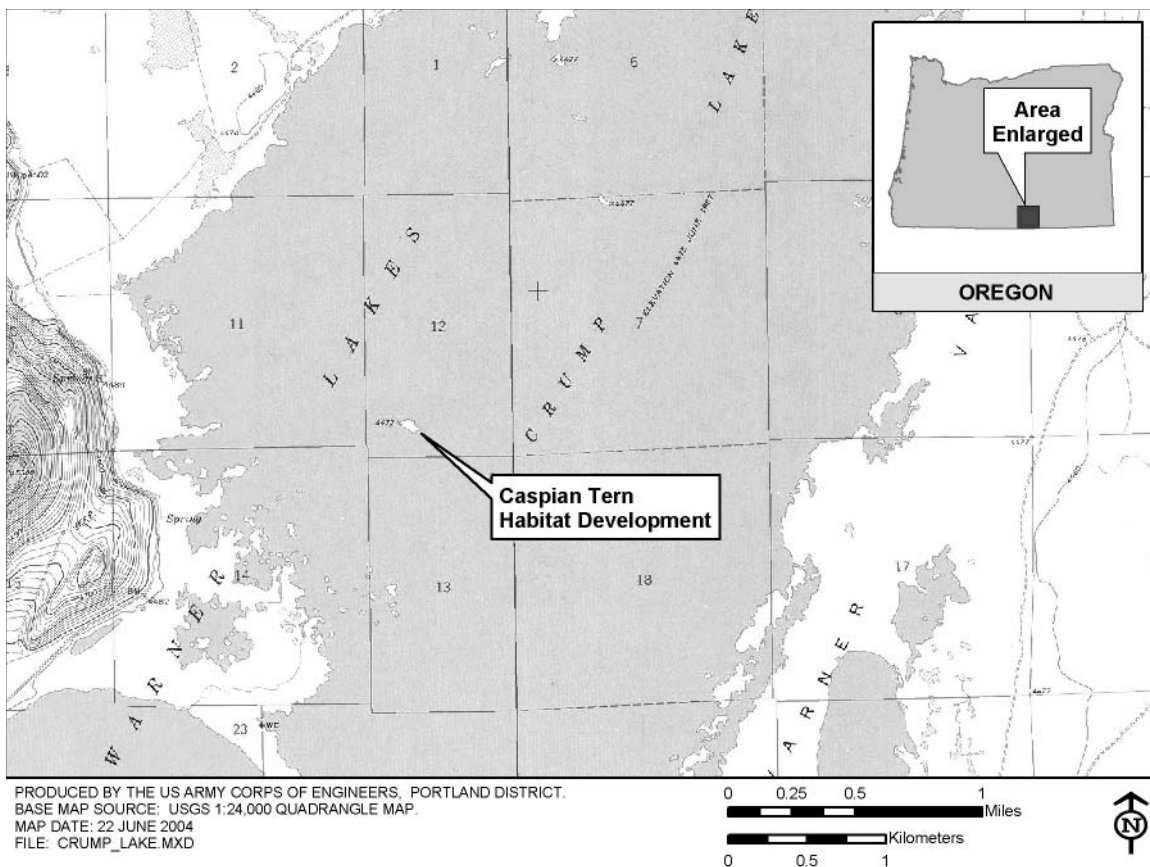


FIGURE G.3 Summer Lake, Oregon

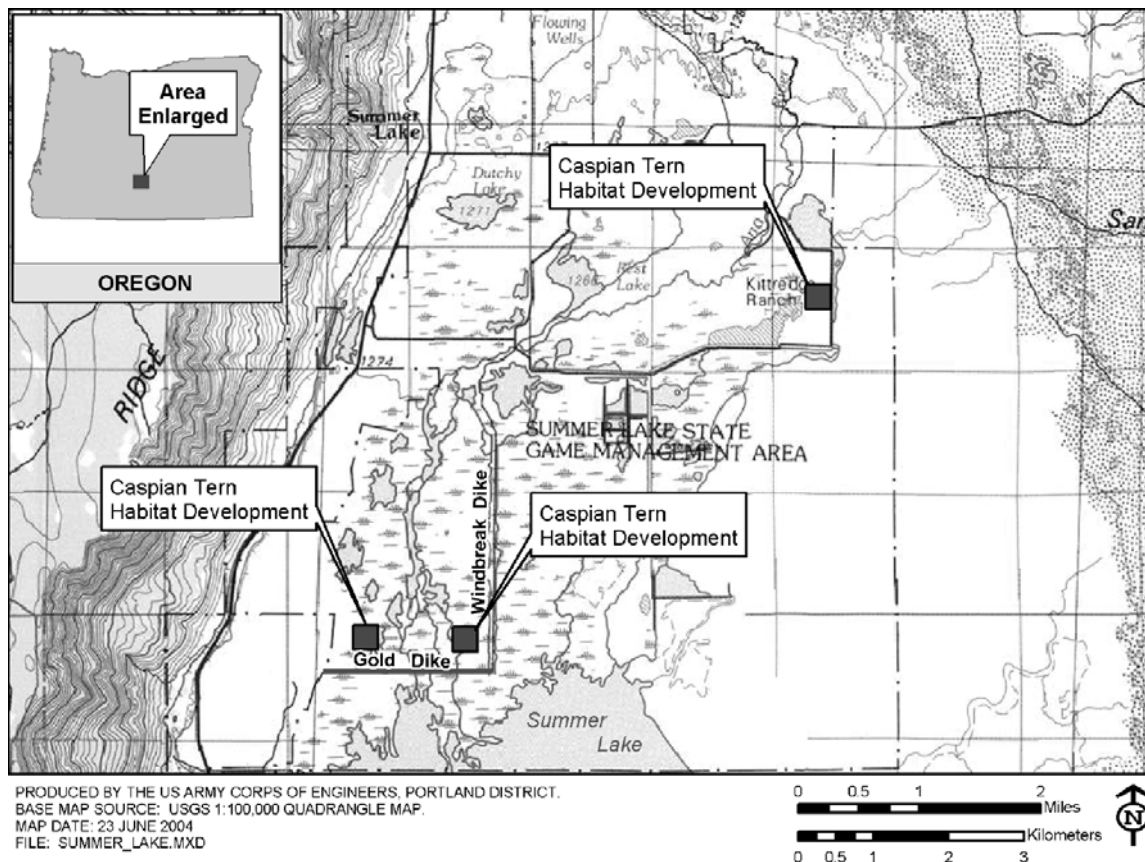
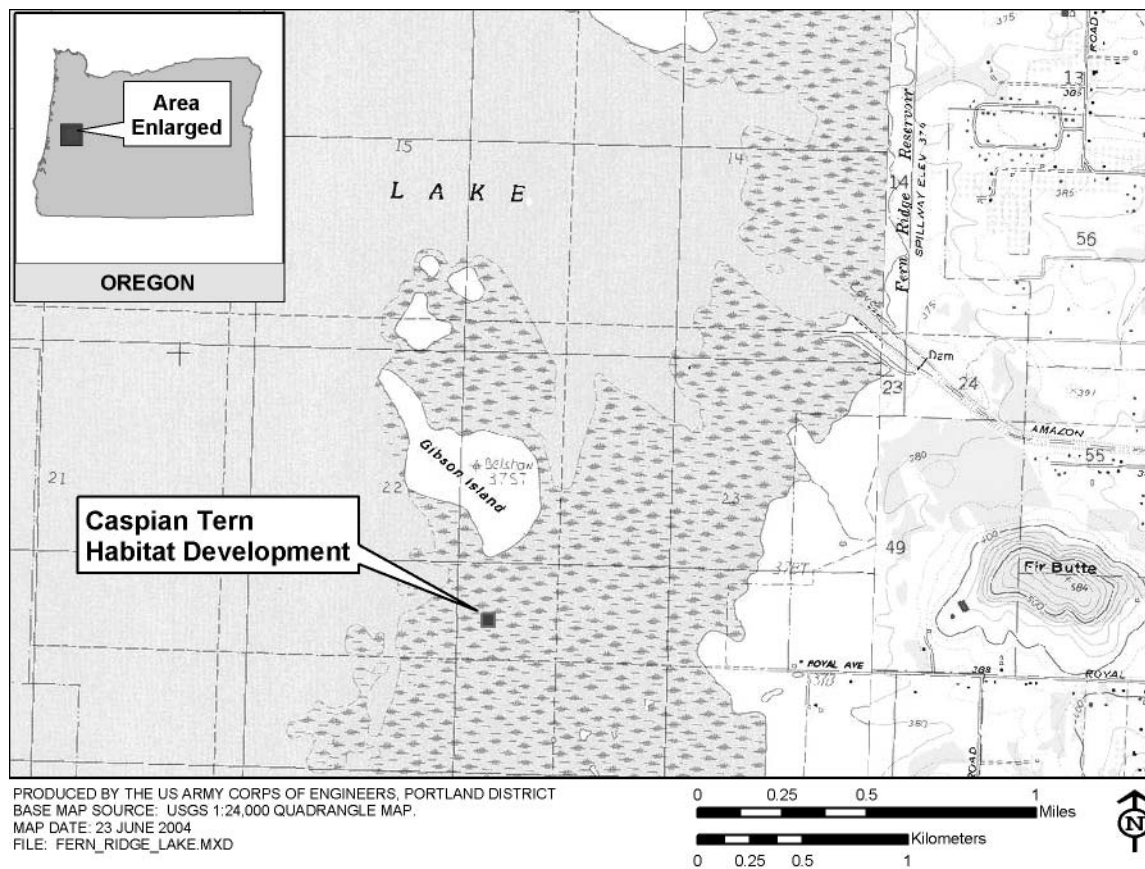


FIGURE G.4 Fern Ridge Lake, Oregon



excavators would be used to push material to the island from adjacent land. The second construction method would obtain the necessary borrow material from dry soil formerly sidecast from the maintenance excavation of the East Link canal. This material would need to be trucked into the site. Once the island is completed, a top dressing of relatively fine gravels (approximately pea-size or smaller) obtained from an ODFW quarry would be placed on the island. This material would provide a suitable nesting substrate for terns. A construction access road would be constructed for gravel trucks to reach the constructed island. Upon completion of the project, the road would be sidecast back into the borrow pits from which it was constructed.

Two additional 0.5 acre-islands would also be constructed off the Windbreak and Gold dikes. Both of these dikes are located within a diked impoundment. As with the East Link location, the impoundment would need to be allowed to dry before construction, again preceded by a drawdown initiated in late November to early December. Construction at these sites would occur as described above for the East Link site. As with Crump Lake, social attraction techniques would also be used to attract terns to all three islands that would be constructed at this site.

Estimated costs: \$ 600,873.00 (first year costs, including construction and monitoring)

Fern Ridge Lake. Fern Ridge Lake (Figure G.4), in the southern Willamette Valley of Oregon, currently contains no appropriate nesting habitat for Caspian terns. The Corps has prepared a conceptual draft for the construction of a 1-acre island in the reservoir to serve as nesting habitat for terns (U.S. Army Corps of Engineers 1998). We propose to implement this project and attract terns to the site with social attraction techniques. A 1-acre island would be constructed off Royal Avenue within the full pool boundary.

Estimated costs: \$ 428,807.00 (first year costs, including construction and monitoring)

San Francisco Bay, Brooks Island. In San Francisco Bay, California (Figure G.5), there are several sites that could be enhanced for Caspian terns. On Brooks Island (Figure G.6), we propose to assist the East Bay Regional Parks Department in removing vegetation adjacent to the current tern nesting area to create more open habitat for nesting terns. Open habitat at higher elevations would help eliminate the possibility of nest loss due to flooding at high tide. Increased enforcement of area closures would also protect the tern nesting colony. Rats have been documented on the island and may need to be controlled or eliminated to ensure long-term nesting success for the terns. Predator control (avian and

mammalian), may also be necessary. In addition, we would explore various methods to prevent erosion of the spit at Brooks Island that is currently occurring. Estimated costs: \$ 56,000.00 (first year costs, including habitat management and monitoring)

Ponds N1/N9. Ponds N1/N9 in the Don Edwards San Francisco Bay NWR (Figure G.7) are active salt ponds with numerous internal levees that are closed to visiting public. Although nesting terns have used nearby areas, no nesting activity has been documented at this site. Nesting habitat could be created for terns by enhancing nesting substrate and increasing predator control. Gravel or oyster shells would be deposited on the site via helicopter. Social attraction techniques would also be used.

Estimated costs: \$ 174,000.00 (first year costs, including construction and monitoring)

Hayward Regional Shoreline. Hayward Regional Shoreline (Figure G.8) is also managed by East Bay Regional Parks. This site contains a number of inactive salt ponds that are now managed for various wildlife species. Numerous islands are found throughout the former salt ponds. A single pair of Caspian terns has nested at this site in recent years. Nesting habitat can be enhanced on Islands 2, 6, and 7 and include removing existing vegetation, installing a weed barrier fabric, saturating the site with salt to prevent vegetation growth, and improving the substrate with sand or oyster shells (via helicopter). Social attraction techniques would also be used.

Estimated costs: \$ 174,000.00 (first year costs, including construction and monitoring)

FIGURE G.5 Caspian Tern Management Sites in San Francisco Bay, California

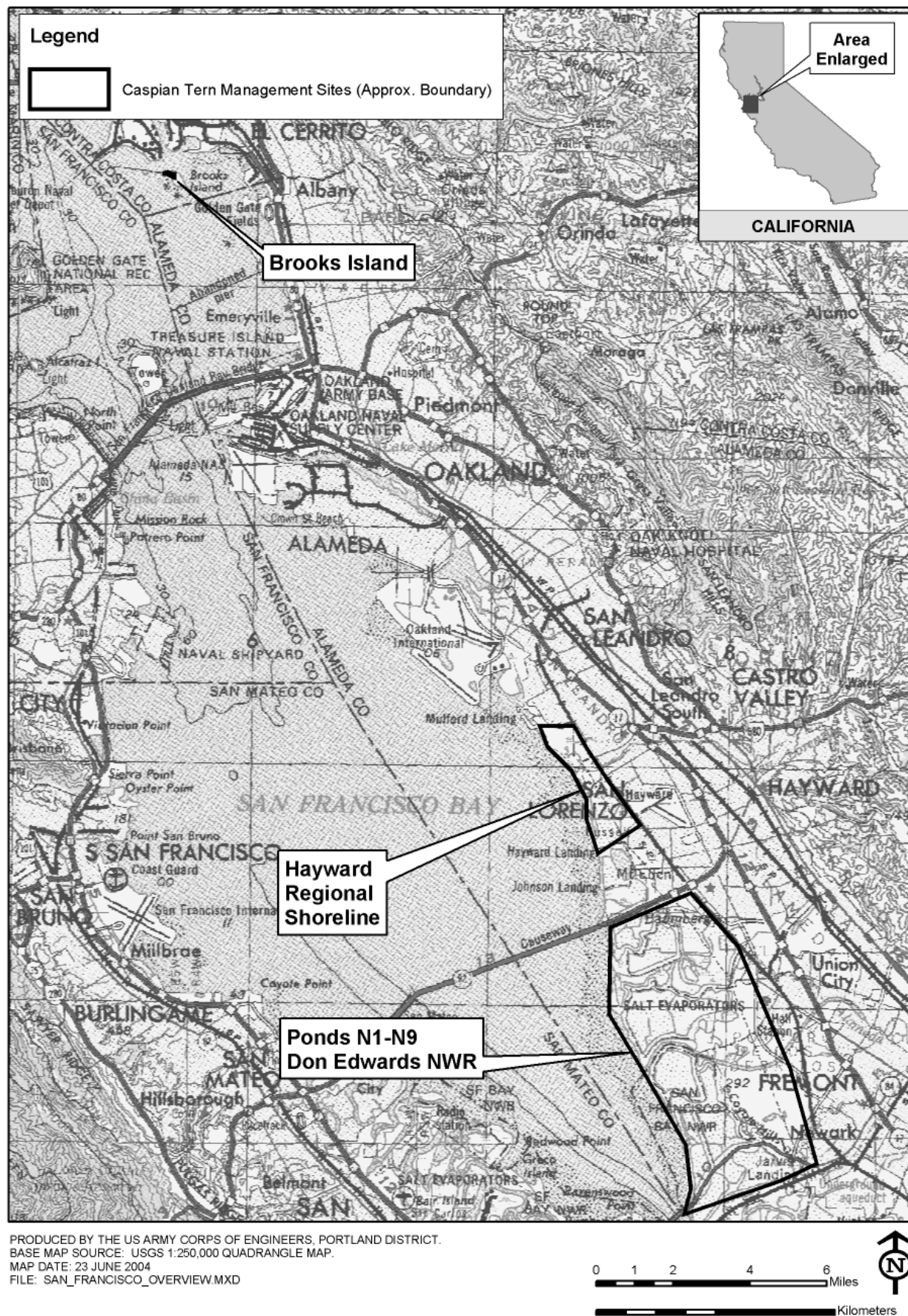


FIGURE G.6 Brooks Island, San Francisco Bay, California

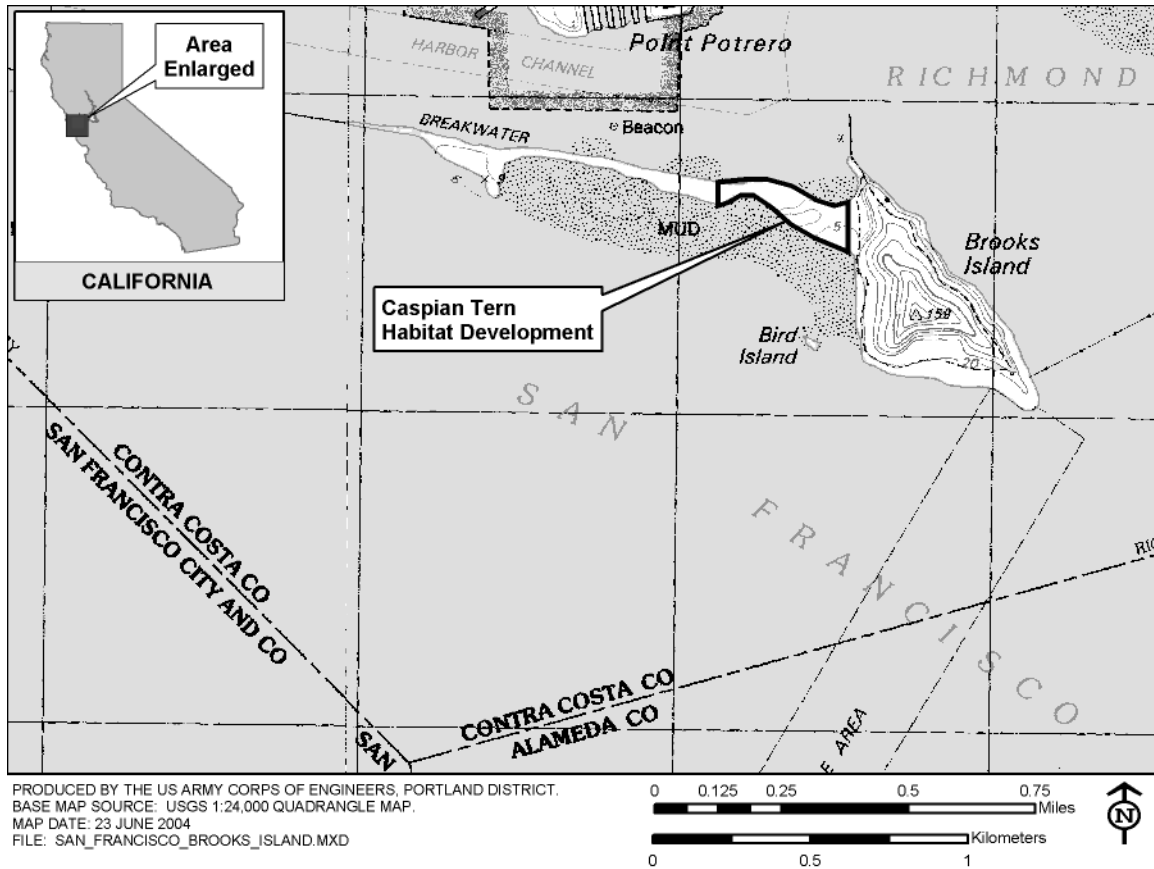


FIGURE G.7 Ponds N1/N9 in the Don Edwards San Francisco Bay NWR, California

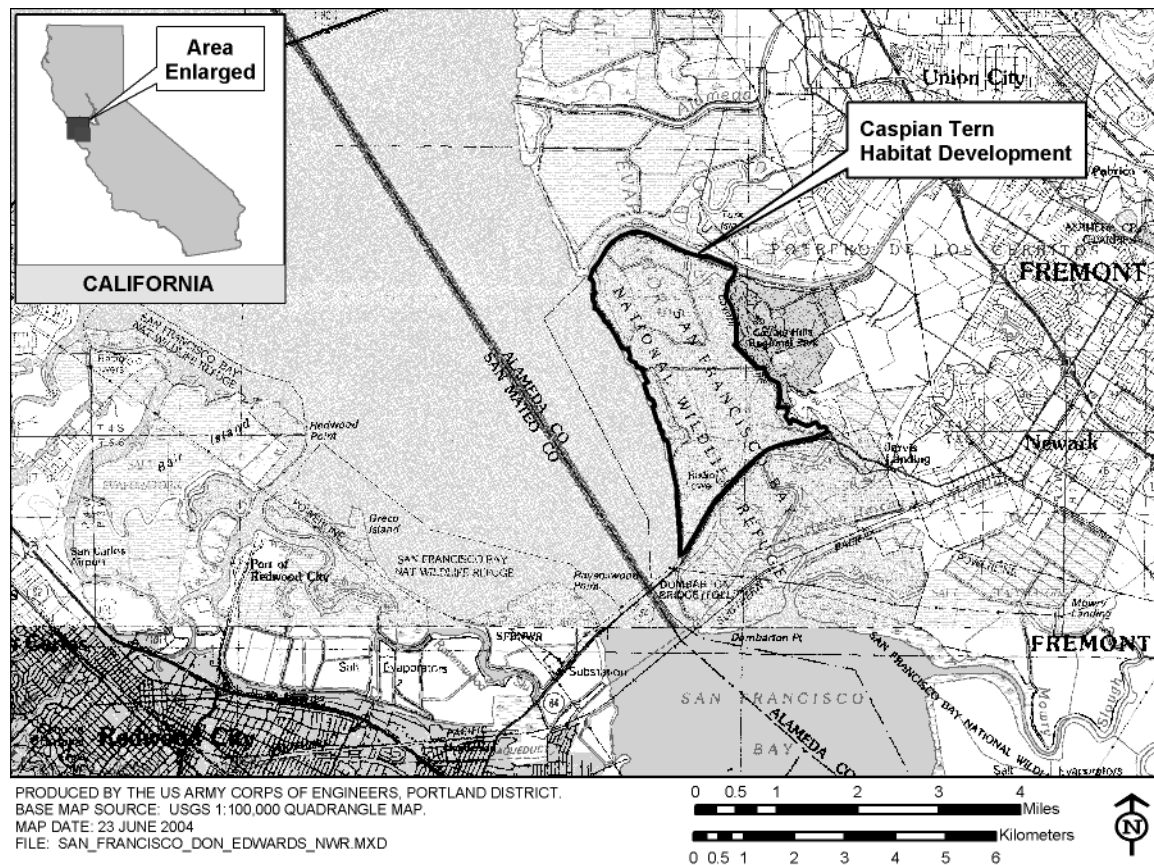


FIGURE G.8 Hayward Regional Shoreline, California

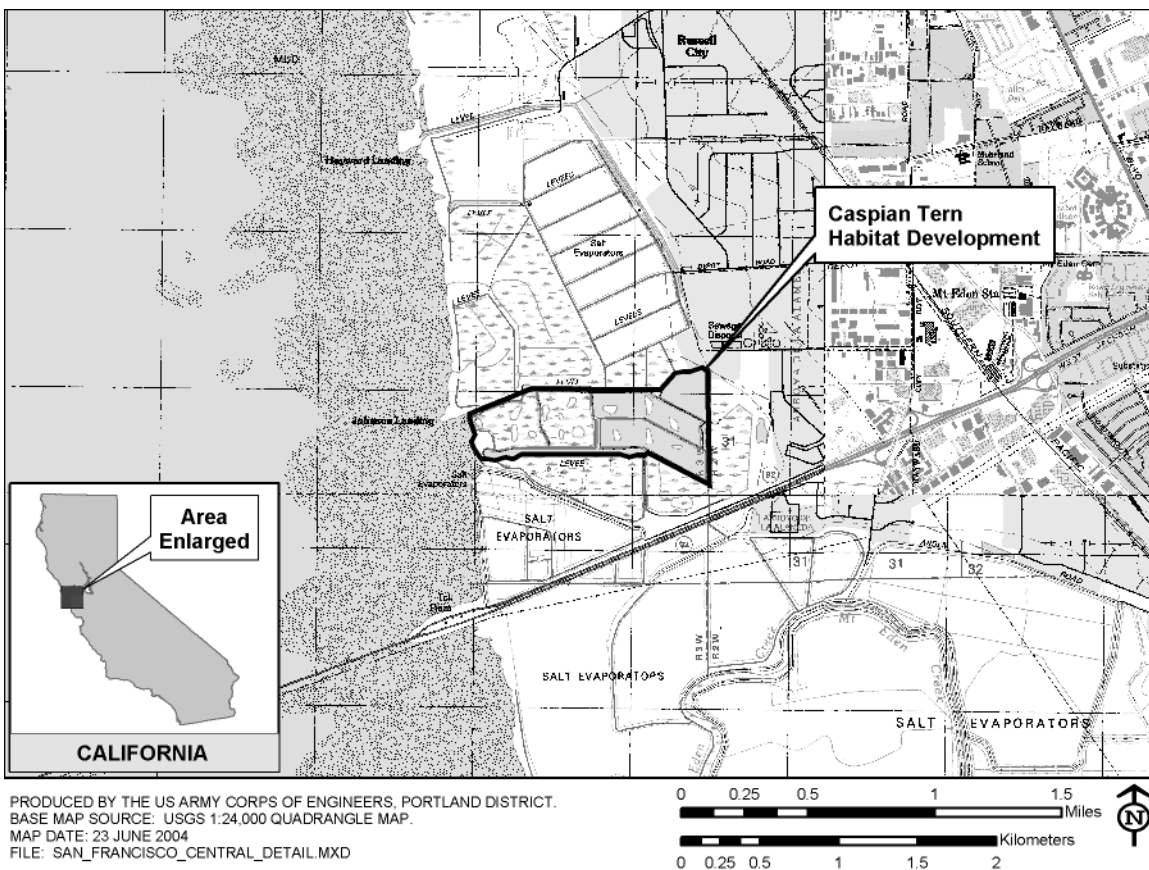


Table G.1 Assessment of Caspian tern habitat management potential at 77 sites in the Pacific Coast/Western Region. ^a

Site Name	Management Potential		Factors limiting Management Potential
	Yes	No	
COASTAL WASHINGTON			
Sand Island, Grays Harbor	x		
No Name Island, Grays Harbor	x		
Unnamed Island, Grays Harbor	x		
Cate Island, Grays Harbor	x		
Bldg 407, Commencement Bay		x	Landowner will discourage birds
McNeil Island, Puget Sound		x	No site available
Snag Islands, Willapa Bay		x	No stable nesting habitat
Unnamed Island, Padilla Bay	x		
Jetty Island, Puget Sound	x		
INTERIOR WASHINGTON			
Solstice Island, Potholes Reservoir		x	Fluctuating reservoir water levels
Unnamed Island, Potholes Reservoir		x	Fluctuating reservoir water levels
Harper Island, Sprague Lake		x	Poor nesting substrate
Unnamed Island # 1, Banks Reservoir		x	Fluctuating reservoir water levels
Unnamed Island #2, Banks Reservoir		x	Fluctuating reservoir water levels
Goose Island, Banks Reservoir		x	Fluctuating reservoir water levels
MID-COLUMBIA RIVER			
Crescent Island		x	Will not reduce Columbia River impacts
Straight Six Island, Umatilla		x	Will not reduce Columbia River impacts
No Name Island #1, Umatilla		x	Will not reduce Columbia River impacts
No Name Island # 2, Umatilla		x	Will not reduce Columbia River impacts
No Name Island #3, Umatilla		x	Will not reduce Columbia River impacts
“Test” Island, Umatilla		x	Will not reduce Columbia River impacts
Miller Rocks		x	No available habitat
Threemile Canyon Island		x	Will not reduce Columbia River impacts
COASTAL OREGON			
Unnamed Island, Coos Bay	x		
“South” Island, Coos Bay		x	Heavily vegetated, heavy boat traffic
“Middle” Island, Coos Bay		x	Heavily vegetated, heavy boat traffic

Table G.1 (Cont.) Assessment of Caspian tern habitat management potential at 77 sites in the Pacific Coast/Western Region. ^a

Site Name	Management Potential		Factors limiting Management Potential
	Yes	No	
"North" Island, Coos Bay		x	Heavily vegetated, heavy boat traffic
Unnamed Island, Umpqua River Estuary	x		
Steamboat Island, Umpqua River Estuary	x		
Fern Ridge Reservoir, Oregon	x		
INTERIOR OREGON/NEVADA			
Pelican/Crump Lake, Oregon		x	Site availability varies annually
Summer Lake, Oregon		x	Site availability varies annually
Tern Island, Malheur Lake		x	Site availability varies annually
Anaho Island, Pyramid Lake		x	Inadequate prey base
Stillwater National Wildlife Refuge		x	Site availability varies annually
Carson Sink, Nevada		x	Site availability varies annually
SOUTHERN IDAHO			
Unnamed Island, Mormon Reservoir		x	Site availability varies annually
Tern Island, Minidoka NWR		x	Site availability varies annually
Gull Island, American Falls Reservoir		x	Site availability varies annually
Gull Island, Blackfoot Reservoir		x	Site availability varies annually
Unnamed Island, Bear Lake NWR		x	Site availability varies annually
NORTHERN COASTAL CALIFORNIA			
Sand Island, Humboldt Bay	x		
Knight Island, San Pablo Bay	x		
Brooks Island, San Francisco Bay	x		
Runway wetland, Alameda NWR	x		
West wetland, Alameda NWR	x		
Pond A7, South San Francisco Bay	x		
Pond A16, South San Francisco Bay	x		
Pond 10, Baumberg Tract, San Francisco Bay	x		
Elkhorn Slough, Monterey Bay	x		
Salinas River, Monterey Bay		x	Incompatible with management for snowy plovers
SOUTHERN COASTAL CALIFORNIA			
Terminal Island, Los Angeles Harbor		x	Limited habitat

Table G.1 (Cont.) Assessment of Caspian tern habitat management potential at 77 sites in the Pacific Coast/Western Region. ^a

Site Name	Management Potential		
	Yes	No	Factors limiting Management Potential
Upper Newport Bay Ecological Reserve, Newport	x		
Bolsa Chica Ecological Reserve, Huntington Beach	x		
South San Diego Bay NWR, Saltworks		x	Limited habitat
NORTHEASTERN CALIFORNIA			
Meiss Lake, Butte Valley Wildlife Area		x	Site availability varies with annual precipitation
Lower Klamath NWR	x		
Tule Lake NWR	x		
Clear Lake NWR		x	Site availability varies with annual precipitation
Goose Lake		x	Site availability varies with annual precipitation Site
Bird Island, Big Sage Reservoir		x	Site availability varies with annual precipitation Site
Honey Lake Wildlife Area		x	Site availability varies with annual precipitation Site
Mono Lake		x	Inadequate prey in close proximity
TULARE BASIN			
Lemoore Naval Air Station		x	Site availability varies with annual precipitation
Westlake Farms North Evaporation Basin		x	Site availability varies with annual precipitation
Tulare Lakebed		x	Site availability varies with annual precipitation
Westlake Mitigation Wetland, section 3		x	Site availability varies with annual precipitation
Westlake Farms South Evaporation Basin		x	Site availability varies with annual precipitation
South Wilbur Flood Area		x	Site availability varies with annual precipitation
Hacienda Ranch Flood Basin		x	Site availability varies with annual precipitation
Tulare Lake Drainage District, South Evaporation Basin		x	Site availability varies with annual precipitation
SOUTHERN INTERIOR CALIFORNIA			
Obsidian Butte, Salton Sea		x	Long-term availability of site uncertain
Morton Bay, Salton Sea		x	Long-term availability of site uncertain
Headquarters Unit "D," Salton Sea		x	Long-term availability of site uncertain
Mullet Island, Salton Sea		x	Long-term availability of site uncertain
Unit 1-B4, Salton Sea NWR		x	Long-term availability of site uncertain
Unit 1-A4, Salton Sea NWR		x	Long-term availability of site uncertain

^a Table taken from Table 7 in Seto, N., J. Dillon, W.D. Shuford, and T. Zimmerman. 2003. A review of Caspian tern (*Sterna caspia*) nesting habitat: a feasibility assessment of management opportunities in the U.S. Fish and Wildlife Service Pacific Region.

TABLE G.2 Potential Caspian tern management sites ranked by Tier I criteria and Categorical Factor assignments.^a

Sites with Management Potential	Ranking Criteria						Sum of Tier I Ranks	Categorical Factor
	Site Status ^b	Potential Conflict with Salmon ^c	Proximity to East Sand Island ^d	Site Capacity ^e	Conflicts with other listed species (non-salmonids) ^f	Site Availability ^g		
COASTAL WASHINGTON								
Sand Island, Grays Harbor	3	3	3	5	3	5	22	H
No Name Island, Grays Harbor	0	3	3	5	3	3	17	M
Unnamed Island, Grays Harbor	0	3	3	3	3	5	17	M
Cate Island, Grays Harbor	0	3	3	3	3	3	15	M
Whitcomb Island, Grays Harbor	3	3	3	5	3	0	17	M
Unnamed Island, Padilla Bay	3	3	1	1	5	3	16	M
Jetty Island, Puget Sound	0	3	1	5	5	3	17	M
COASTAL OREGON								
Unnamed Island, Coos Bay	0	3	2	1	3	3	12	L
Unnamed Island, Umpqua River Estuary	0	3	2	1	5	3	14	L
Steamboat Island, Umpqua River Estuary	0	3	2	1	5	3	14	L
Fern Ridge Reservoir	0	3	2	5	5	0	15	M
NORTHERN COASTAL CALIFORNIA								
Sand Island, Humboldt Bay	5	3	1	1	5	5	20	H
Knight Island, San Francisco Bay	5	3	1	3	5	3	20	H
Brooks Island, San Francisco Bay	5	3	1	5	5	5	24	H
Runway wetland, Alameda, San Francisco Bay	3	3	1	3	3	3	16	M
West Wetland, Alameda, San Francisco Bay	3	3	1	3	3	3	16	M

TABLE G.2 (cont.) Potential Caspian tern management sites ranked by Tier I criteria and Categorical Factor assignments.^a

Sites with Management Potential	Ranking Criteria						Categorical Factor
	Site Status ^b	Potential Conflict with Salmon ^c	Proximity to East Sand Island ^d	Site Capacity ^e	Conflicts with other listed species (non-salmonids) ^f	Site Availability ^g	
Salt Pond A7, South San Francisco Bay	5	3	1	3	3	3	H
Salt Pond A16, South San Francisco Bay	0	3	1	1	3	5	L
Baumberg Pond, San Francisco Bay	5	3	1	1	3	3	M
Elkhorn Slough, Monterey Bay	5	5	1	1	3	3	H
SOUTHERN COASTAL CALIFORNIA							
Bolsa Chica Ecological Reserve, Huntington Beach	5	5	1	3	3	0	M
Upper Newport Bay Ecological Reserve, Newport Beach	0	5	1	3	3	3	M
NORTHEASTERN INTERIOR							
Lower Klamath NWR	3	5	1	3	5	0	M
Tule Lake NWR	3	5	1	3	5	0	M

^b Site Status: 5 = nesting colony currently active, 3 = historic nesting colony, 0 = no recorded Caspian tern nesting^c Conflict with salmonids: 5 = salmon not available as potential prey item, 3 = salmon present as potential prey but good abundance of non-salmonid prey items, 1 = salmon comprises primary prey base^d Proximity to East Sand Island: 3 = site less than 200 km from East Sand Island, 2 = site 200-500 km from East Sand Island, 1 = site greater than 500 km from East Sand Island^e Site Capacity: 5 = greater than 2000 nesting pairs, 3 = 350-1000 nesting pairs, 1 = less than 350 nesting pairs^f Conflicts with other listed species or species of concern (non-salmonids): 5 = no listed species present, 3 = listed species present but low likelihood of conflict, 1 = listed species present and relatively high potential for conflict^g Site Availability: 5 = site currently suitable or requires minimal habitat enhancement, 3 = site available after extensive manipulation, 0 = site needs to be constructed^a Table taken from Table 8.A in Seto, N., J. Dillon, W.D. Shuford, and T. Zimmerman. 2003. A review of Caspian tern (*Sterna caspia*) nesting habitat: a feasibility assessment of management opportunities in the U.S. Fish and Wildlife Service Pacific Region.

TABLE G.3 Potential Caspian tern management sites ranked by Tier II criteria and Total Site Scores.^a

Sites	Ranking Criteria				Sum of Tier II Ranks	Total Site Score
	Habitat Management ^b	Human Disturbance ^c	Potential Predators ^d			
High Category (*5)						
Elkhorn Slough, Monterey Bay	2	3	1	6	30	
Sand Island, Grays Harbor	2	5	3	10	50	
Brooks Island, San Francisco Bay	2	3	5	10	50	
Sand Island, Humboldt Bay	3	5	5	13	65	
Knight Island, San Francisco Bay	3	5	5	13	39	
Salt Pond A7, South San Francisco Bay	3	5	5	13	39	
Medium Category (*3)						
Unnamed Island, Grays Harbor	3	5	5	13	39	
No Name Island, Grays Harbor	2	5	3	10	30	
Whitcomb Island, Grays Harbor	3	5	5	13	39	
Cate Island, Grays Harbor	2	3	1	6	18	
Unnamed Island, Padilla Bay	2	5	3	10	10	
Jetty Island, Puget Sound	1	3	3	7	21	
Fern Ridge Reservoir	2	5	5	12	12	
Runway wetland Alameda NWR, San Francisco Bay	2	5	1	8	24	
West Wetland, Alameda NWR, San Francisco Bay	2	5	1	8	24	
Baumberg Pond, San Francisco Bay	3	5	5	13	13	
Bolsa Chica Ecological Reserve, Huntington Beach	2	5	5	12	36	
Upper Newport Bay Ecological Reserve, Newport Beach	2	5	3	10	30	

TABLE G.3 (cont.) Potential Caspian tern management sites ranked by Tier II criteria and Total Site Scores.^a

Sites	Ranking Criteria				Sum of Tier II Ranks	Total Site Score
	Habitat Management ^b	Human Disturbance ^c	Potential Predators ^d			
Lower Klamath NWR	1	5	5		11	33
Tule Lake NWR	1	5	5		11	33
Low Category (*1)						
Unnamed Island, Coos Bay	1	5	5		11	11
Unnamed Island, Umpqua River Estuary	1	5	5		11	11
Steamboat Island, Umpqua River Estuary	3	5	5		13	13
Salt Pond A16, South San Francisco Bay	3	5	5		13	13

^a Table taken from Table 8 B in Seto, N., J. Dillon, W.D. Shuford, and T. Zimmerman. 2003. A review of Caspian tern (*Sterna caspia*) nesting habitat: a feasibility assessment of management opportunities in the U.S. Fish and Wildlife Service Pacific Region

^b Habitat maintenance: 3 = short term or infrequent management requirements, 2 = annual habitat maintenance but no heavy equipment required, 1 = annual maintenance and heavy equipment required

^c Human disturbance: 5 = site is relatively inaccessible and no established human use, 3 = site is accessible with a history of human use; disturbance levels are manageable, 1 = site is readily accessible with regular human use and limited opportunities for managing use

^d Predators: 5 = inaccessible to mammals and no known concentration of avian predators in close proximity, 3 = avian and/or mammalian predators on site, but potential impacts to tern colony are low or manageable, 1 = site accessible to mammals and high concentration of avian predators on-site or nearby

TABLE G.4. Sites eliminated from consideration for Caspian Tern Management under Alternatives C and D. Sites are listed in geographical order from north to south.

SITE NAME	REASON FOR ELIMINATION FROM CONSIDERATION
WASHINGTON	
Commencement Bay	Loss of site due to environmental clean-up activities
Padilla Bay	WDFW does not support site development
Jetty Island	WDFW does not support site development
Grays Harbor (4 islands)	WDFW does not support site development
Willapa Bay	Loss of site due to natural erosion
Banks Reservoir (3 islands)	Some nesting terns from this colony forage in the Columbia River, and thus, management of this site for Caspian terns does not support the reduction of tern predation on Columbia River salmon
Potholes Reservoir (2 islands)	Some nesting terns from this colony forage in the Columbia River, and thus, management of this site for Caspian terns does not support the reduction of tern predation on Columbia River salmon
Sprague Lake	Some nesting terns from this colony forage in the Columbia River, and thus, management of this site for Caspian terns does not support the reduction of tern predation on Columbia River salmon
Crescent Island	Location in the Columbia River, and thus, management of this site for Caspian terns does not support the reduction of tern predation on Columbia River salmon
Threemile Canyon Island	Location in the Columbia River, and thus, management of this site for Caspian terns does not support the reduction of tern predation on Columbia River salmon
Miller Rocks	Location in the Columbia River, and thus, management of this site for Caspian terns does not support the reduction of tern predation on Columbia River salmon
OREGON	
Rice Island	Location in the Columbia River, does not support reduction of tern predation on Columbia River salmon
Miller Sands Spit	Location in the Columbia River, does not support reduction of tern predation on Columbia River salmon
Coos Bay	ODFW does not support site development
Umpqua Estuary	ODFW does not support site development
CALIFORNIA	
Humboldt Bay NWR	CDFG and Service California/Nevada Office does not support site development
Knight Island, San Francisco Bay	Loss of nesting area to tidal restoration project by CDFG
Bair Island, San Francisco Bay	Loss of nesting area and restoration not feasible
Turk Island, San Francisco Bay	Loss of nesting area, restoration not feasible
Baumberg Tract, San Francisco Bay	Nesting habitat currently maximized, habitat enhancement not feasible
Alviso (Pond A7), San Francisco Bay	Nesting habitat currently maximized and concerns associated contaminant issues
Moss Landing salt ponds, Monterey Bay	Loss of site
Elkhorn Slough Ecological Reserve	Nesting habitat is not maximized, no habitat enhancement necessary
Pier 400, Terminal Island	Nesting habitat currently maximized, habitat enhancement not feasible
Clear Lake NWR	Nesting habitat is not lacking

TABLE G.4. Sites eliminated from consideration for Caspian Tern Management under Alternatives C and D. Sites are listed in geographical order from north to south.

SITE NAME	REASON FOR ELIMINATION FROM CONSIDERATION
CALIFORNIA (continued)	
Lower Klamath NWR	Loss of site; extremely small historic nesting colony (15-27 pairs), last nested in 1976
Tule Lake NWR	Loss of site; small historic nesting colony (3-80 pairs), last nested in 1962
Mono Lake	Extremely small nesting colony (6 -8 nesting pairs)
Lemoore NAS sewer ponds	Extremely small nesting colony (0-20 nesting pairs)
Yolo Bypass Wildlife Area	CDFG does not support site development
City of Davis Wetlands	CDFG does not support site development
Westlake Farms South Evaporation Basin	Extremely small nesting colony (0 -3 nesting pairs)
Tulare lakebed	Extremely small nesting colony (0 -20 nesting pairs)
South Wilbur Flood Area	Extremely small nesting colony (0-70 nesting pairs)
Tulare Lake Drainage District	Extremely small nesting colony (0-1 nesting pairs)
Tulare Lake Drainage District	Extremely small nesting colony (0-40 nesting pairs)
Lake Elsinore	Extremely small nesting colony (0 -14 nesting pairs); high potential for human disturbance
Salton Sea	Uncertainty of long term water management and prey availability due to potential water transfer from Imperial Irrigation District to San Diego
IDAHO	
Mormon Reservoir	Availability of nesting habitat varies from year to year because of reservoir water levels; large distance from East Sand Island colony
Magic Reservoir	Availability of nesting habitat varies from year to year because of reservoir water levels; large distance from East Sand Island colony
Blackfoot Reservoir	Availability of nesting habitat varies from year to year because of reservoir water levels; large distance from East Sand Island colony
Minidoka NWR	Lack of nesting habitat; large distance from East Sand Island colony
Deer Flat NWR (Snake River Island)	Lack of nesting habitat; large distance from East Sand Island
Bear Lake NWR	Lack of nesting habitat; large distance from East Sand Island
NEVADA	
Carson Sink	Nesting habitat only available during high water/flood years
Anaho Island NWR	Lack of prey base
Stillwater Point Reservoir	Nesting habitat only available during high water/flood years

Appendix H. Scientific Names for Fish, Wildlife and Plants

Federally Endangered and Threatened Fish and Wildlife

Common Name	Scientific Name	Status
Birds		
California brown pelican	<i>Pelecanus occidentalis</i>	E
California clapper rail	<i>Rallus longirostris obsoletus</i>	E
California least tern	<i>Sterna antillarum browni</i>	E
Marbled murrelet	<i>Brachyramphus marmoratus</i>	T
Bald eagle	<i>Haliaeetus leucocephalus</i>	T
Western snowy plover	<i>Charadrius alexandrinus</i>	T
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	C
Streaked horned lark	<i>Eremophila alpestris strigata</i>	C
Fish		
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	*
Coho salmon	<i>Oncorhynchus kisutch</i>	*
Chum salmon	<i>Oncorhynchus keta</i>	*
Sockeye salmon	<i>Oncorhynchus nerka</i>	*
Steelhead salmon	<i>Oncorhynchus mykiss</i>	*
Bull trout	<i>Salvelinus confluentus</i>	*
Oregon chub	<i>Oregonichthys crameri</i>	E
Tidewater goby	<i>Eucyclogobius newberryi</i>	E
Lost River sucker	<i>Deltistes luxatus</i>	E
Shortnose sucker	<i>Chasmistes brevirostris</i>	E
Delta smelt	<i>Hypomseus transpacificus</i>	T
Warner sucker	<i>Catostomus warnerensis</i>	T
Green sturgeon	<i>Acipenser medirostris</i>	C
Mammals		
Salt marsh harvest mouse	<i>Reithrodontomys raviventris</i>	E
Riparian brush rabbit	<i>Sylvilagus bachmani riparius</i>	E
San Joaquin kit fox	<i>Vulpes macrotis mutica</i>	E
Riparian (San Joaquin Valley) woodrat	<i>Neotoma fuscipes riparia</i>	E
Reptiles		
Alameda whipsnake	<i>Masticophis lateralis euryxanthus</i>	T
Giant garter snake	<i>Thamnophis gigas</i>	T
Amphibians		
California red-legged frog	<i>Rana aurora draytonii</i>	T
California tiger salamander	<i>Ambystoma californiense</i>	PT
California tiger salamander	<i>Ambystoma californiense</i>	PT
Columbia spotted frog	<i>Rana luteiventris</i>	C
Oregon spotted frog	<i>Rana pretiosa</i>	C
Invertebrates		
Fender's blue butterfly	<i>Icaricia icarioides fenderi</i>	E
Lange's metalmark butterfly	<i>Apodemia mormo langei</i>	E
Callippe silverspot butterfly	<i>Speyeria callippe callippe</i>	E
Conservancy fairy shrimp	<i>Branchinecta conservatio</i>	E

Federally Endangered and Threatened Fish and Wildlife Continued

Common Name	Scientific Name	Status
Invertebrates (Continued)		
Vernal pool tadpole shrimp	<i>Lepidurus packardii</i>	E
Longhorn fairy shrimp	<i>Branchinecta longiantenna</i>	E
Bay checkerspot butterfly	<i>Euphydryas editha bayensis</i>	T
Vernal pool fairy shrimp	<i>Branchinecta lynchi</i>	T
Valley elderberry longhorn beetle	<i>Desmocerus californicus dimorphus</i>	T
Taylor's checkerspot	<i>Euphydryas editha taylori</i>	C
Plants		
Willamette daisy	<i>Erigeron decumbens</i> var. <i>decumbens</i>	E
Bradshaw's lomatium	<i>Lomatium bradshawii</i>	E
Antioch Dunes evening-primrose	<i>Oenothera deltoides</i> ssp. <i>howellii</i>	E
Contra Costa goldfields	<i>Lasthenia conjugens</i>	E
Contra Costa wallflower	<i>Erysimum capitatum</i> ssp. <i>angustatum</i>	E
California sea blight	<i>Suaeda californica</i>	E
Presidio clarkia	<i>Lasthenia conjugens</i>	E
Large-flowered fiddleneck	<i>Amsinckia grandiflora</i>	E
Palmate-bracted bird's beak	<i>Cordylanthus palmatus</i>	E
Soft bird's beak	<i>Cordylanthus mollis</i> ssp. <i>mollis</i>	E
Robust spineflower	<i>Chorizanthe robusta</i> var. <i>robusta</i>	E
Showy Indian clover	<i>Trifolium amoenum</i>	E
Gold Indian paintbrush	<i>Castilleja levisecta</i>	T
Howellia	<i>Howellia aquatilis</i>	T
Kincaid's lupine	<i>Lupinus sulphureus</i> var. <i>kincaidii</i>	T
Santa Cruz tarplant	<i>Holocarpha macradenia</i>	T
Pallid manzanita	<i>Arctostaphylos pallida</i>	T

Key:

E = Endangered

T = Threatened

PT = Proposed Threatened

C = Candidate

* = see specific ESU listed-status for salmonids in Chapter 3, Table 3.2

Non-Listed Fish, Wildlife and Plants

Common Name

Scientific Name

Wildlife

Birds

American white pelican	<i>Pelecanus erythrorhynchos</i>
Brandt's cormorant	<i>Phalacrocorax penicillatus</i>
Double-crested cormorant	<i>Phalacrocorax auri</i>
Great blue heron	<i>Ardea herodias</i>
Great egret	<i>Ardea alba</i>
Western Canada goose	<i>Branta Canadensis</i>
Brant	<i>Branta bernicla</i>
Mallard	<i>Anas platyrhynchos</i>
Peregrine falcon	<i>Falco peregrinus</i>
Black oystercatcher	<i>Haematopus bachmani</i>
Black-necked stilt	<i>Himantopus mexicanus</i>
American avocet	<i>Recurvirostra americana</i>
Dunlin	<i>Calidris alpina</i>
Common snipe	<i>Gallinago gallinago</i>
Ring-billed gull	<i>Larus delawarensis</i>
California gull	<i>Larus californicus</i>
Western gull	<i>Larus occidentalis</i>
Glaucous-winged gull	<i>Larus glaucescens</i>
Caspian tern	<i>Sterna caspia</i>
Forster's terns	<i>Sterna forsteri</i>

Mammals

Black-tailed deer	<i>Odocoileus hemionus</i>
Mule deer	<i>Odocoileus hemionus</i>
Coyote	<i>Canis latrans</i>
River otter	<i>Lutra canadensis</i>
Nutria	<i>Myocastor Coypus</i>
Skunk	<i>Mephitis spp.</i>
Raccoon	<i>Procyon lotor</i>
Mink	<i>Mustela vison</i>
Beaver	<i>Castor Canadensis</i>
Muskrat	<i>Ondatra zibethicus</i>
Red fox	<i>Vulpes vulpes</i>
Gray fox	<i>Urocyon cinereoargenteus californicus</i>
Cat	<i>Felis catus</i>
Weasel	<i>Mustela spp.</i>
Black-tailed jackrabbit	<i>Lepus californicus</i>
Western harvest mouse	<i>Reithrodontomys megalotis longicaudus</i>
Voles	Muridae

Fish

Pink salmon	<i>Oncorhynchus gorbuscha</i>
Cutthroat trout	<i>Oncorhynchus clarki</i>
Northern anchovy	<i>Engraulis mordax</i>
Herring	<i>Clupea pallasii</i>
Shiner perch	<i>Cymatogaster aggregata</i>
Pacific sand lance	<i>Ammodytes hexapterus</i>
Sculpin spp.	Cottidae
Surf smelt	<i>Hypomesus pretiosus</i>

Non-Listed Fish, Wildlife and Plants Continued

Common Name	Scientific Name
Fish (Continued)	
Surf perch	Embiotocidae
Silversides	Atherinidae
Sunfish	Centrarchidae
Gobies	Gobiidae
Toadfish	Batrachoididae
Tui chubs	<i>Siphateles bicolor</i>
Rainbow trout	<i>Salmo gairdneri</i>
Pacific cod	<i>Gadus macrocephalus</i>
English sole	<i>Parophrys vetulus</i>
Rockfish	<i>Sebastes spp.</i>
White sturgeon	<i>Acipenser transmontanus</i>
Starry flounder	<i>Platichthys stellatus</i>
American shad	<i>Alosa sapidissima</i>
Black Crappie	<i>Pomoxis nigromaculatus</i>
Sacramento splittail	<i>Pogonichthys macrolepidotus</i>
Striped bass	<i>Morone saxatilis</i>
Marine Invertebrates	
Dungeness crab	<i>Cancer magister</i>
Plants	
Red alder	<i>Alnus rubra</i>
Willow species	<i>Salix spp.</i>

Appendix I. List of Preparers

<u>Name</u>	<u>Position</u>	<u>Education</u>	<u>Years of Experience</u>
U.S. Fish and Wildlife Service			
Nanette Seto	Wildlife Biologist	BS, Zoology MS, Wildlife Biology	13
Michelle Whalen	Technical Writer	BA, Language and Literature	10
Tara Zimmerman	Chief, Branch of Bird Conservation	BS, Wildlife Management	25
U.S. Army Corps of Engineers			
Geoff Dorsey	Wildlife Biologist	BS, Wildlife Science MS, Wildlife Science	23
Gregg Bertrand	Geographer	BS, Geography	19
NOAA Fisheries			
Jim Bottom	Technical Editor	BJ, MA Journalism	15
Cathy Tortorici	Chief, Oregon Coast/Lower Columbia River Branch	MA, Biology	15